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Cooperation in Wildland Research

ANNUAL REPORT - 1958

CALIFORNIA

FOREST AND RANGE

EXPERIMENT STATION

FOREST SERVICE

U. S. DEPARTMENT OF AGRICULTURE

FOREWORD

The California Forest and Range Experiment Station is the research branch of the U. S. Forest Service in California. It is charged by Congress with responsibility for solving technical problems that arise from management of all types of wildland in the State. The Station fills an important need on state and private lands as well as federal lands, by conducting more than 50 percent of the research done on wildland. Its corps of more than 100 research specialists combines the experienced judgment of men who know California intimately with the scientific skills of men recently trained in the country's finest universities. For 30 years the staff has been solving wildland management problems with financial support from federal, state, and private sources.

A departure from our usual annual report seems appropriate this year. California is the first state to prepare a complete "Wildland Research Plan". The need for new scientific knowledge to help solve current and future wildland management problems is becoming increasingly acute. The University of California has reacted to this need by forming a Wildland Research Center. The State Board of Forestry has recognized it by appointing an advisory committee on forest research. To give the Station's stockholders a better idea of our role in this effort we have chosen to make this special two-part report on cooperation in wildland research.

The first part outlines in 9 pages our chief activities this year and the adjustments we have made to keep abreast of developing demands on wildland resources. It also describes our major cooperative research projects, which help keep our research geared to day-to-day management problems through participation in our research program by several industry, state, university, and other groups. The second part of this report is a guide to field laboratories where we do much of the Station's experimental work. These facilities are used by our cooperators in forest research, and the guide has been printed as a separate supplement to provide an inventory of the facilities that are available for future work.

We hope this report will give our stockholders a better understanding of our responsibilities and work as a member of the scientific team responsible for producing and harvesting timber, forage, water, and other crops from California's wildlands.

KEITH ARNOLD, Director

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THE YEAR IN BRIEF

This past year the Station shifted emphasis in some of its studies to provide for more effective cooperation and to meet the needs stimulated by management's ever widening interest in using research findings. Forest pest studies emphasized biological control of insects and basic studies of dwarfmistletoe and of blister rust diseases. In forest fire research, we expanded the Fuel-Break project, and planned new work with defense agencies on problems related to survival in mass fires. The Station was given responsibility for an interregional study of log and tree quality standards for ponderosa pine and associated species. Forest genetics workers laid the foundation for commercial production of hybrid pines. Range researchers completed plans for new long-term studies of foothill grazing systems.

As most Station visitors know, next year we will move to new quarters just off the University of California campus in Berkeley. This year we have been planning for modern laboratories in the new building that is already under construction.

RESEARCH IN FOREST PROTECTION

Forest pest conditions surveyed

The annual forest pest survey showed that bark beetle activity in California was well below last year's except in high country forests. To illustrate, losses in uncut ponderosa pine stands at Blacks Mountain Experimental Forest were only 62.5 board-feet per acre, against 207 board-feet a year ago. The mountain pine beetle was epidemic in some lodgepole pine stands, and some Jeffrey pine stands showed signs of increased beetle activity. The lodgepole needle miner remained epidemic at Tuolumne Meadows and caused some damage in forests to the north, east, and south. Cone and seed insects destroyed much of the Douglas-fir cone crop. Damage to the pine cone crop was moderate.

Abundant moisture this year created favorable conditions for outbreaks of foliage diseases on conifers and hardwoods. Among the hardwoods, blights and rusts hit black oak, California laurel, poplar, and aspen especially hard. A new system of random plots speeded disease survey work and showed that dwarfmistletoe is widespread. About half the plots—sampling the entire state—had infected trees. Heart rots were present on 85 percent of the plots.

New studies seek biological control of insects

Two new studies in biological control of forest insects were started. One, with the Pacific Northwest Station, aims to find out if bark beetles are affected by diseases and whether diseases can be used deliberately to control the beetles. One disease-producing organism has been isolated thus far, and several other possible natural enemies of bark beetles have turned up. The second, with the University of California, seeks to learn whether any of many parasites and predators of the lodgepole needle miner are important enough to be of practical use. The bulk of the new work is being done by the University's Department of Biological Control.

Sprays control insects in field trials

Tests with chemicals designed to remain lethal long after they are sprayed on bark beetle-infested pines are confirming laboratory findings. From laboratory studies we know, for example, that California five-spined engraver adults are especially susceptible to lindane. In field trials with infested pine bolts, doses as low as 20 milligrams per square foot of bark were enough to cause almost a complete kill of emerging beetles. In other studies malathion sprays applied by helicopter killed 75-80 percent of the moths and young larvae of the lodgepole needle miner. The dosage was high, 2 pounds of malathion in 20 gallons of diesel oil per acre, and the mortality inadequate for checking outbreaks but enough to stave off tree mortality.

Dwarfmistletoe biology studied in new work

Dwarfmistletoe research was strengthened this year through Forest Service grants to the University of California at Davis and at Berkeley. In the Botany Department at Davis, anatomical studies of the parasite and of the infected and noninfected conifer host indicate that (1) different species of dwarfmistletoe show different degrees of parasitism and (2) the parasite is in direct contact with tissues that carry water in the host, but the contact is indefinite in food-conducting tissues. The Plant Pathology Department at Berkeley is emphasizing studies on factors affecting the germination of dwarfmistletoe seed, biological control, and the basis for host specialization.

Billions of spores—where do they go?

Studies of the behavior of white pine blister rust emphasized inquiries on the long-distance spread of spores from sugar pine to wild gooseberries and currants. In the central Sierra Nevada, preliminary tests were made of spore-trapping techniques from an airplane and from anchored weather balloons. Work on the development and testing of blister rust resistant sugar pine was highlighted by location of 30 new candidate trees in northern California. Besides grafting sugar pine twigs for tests of rust resistance, we are testing chemicals and techniques for vegetative propagation by methods other than grafting.

Fuel-Break goes into action

Fuel-Break, a project aimed at findings ways of breaking vast expanses of heavy fuel into small manageable units benefited from an expanded budget this year. The program leader was assigned to southern California, where fire control is especially difficult because of the continuous stands of chaparral. We have started all three phases of the program—practical application of what is known, pilot tests of promising methods, and research seeking new knowledge. First priority in new fuel studies was assigned to work on seasonal and daily changes in fuel moisture in both dead and green fuels.

Air attack continues to ease fire fighting

Air attack of forest fires has quickly passed from research to operational stages, but the Station continues to feed new information into the program by conducting training sessions in use of helicopters, making hover-jump tests, and outlining guidelines for use of air tankers. The search for newer and better fire retardants continues, both in the Richmond fire laboratory and in the field. Most promising of the dozen or so new materials was bentonite clay.

Fire prevention studies start field trials

Fire prevention research moved into the field with questionnaires designed to test the fire prevention knowledge of hunters. From this trial, public survey specialists will perfect methods of learning what the forest users know about fire prevention, where they receive their information, and how they apply this knowledge. The Station also helped the California Division of Forestry design a randomized cloud seeding pattern for a lightning prevention study in Lassen and Plumas Counties.

Wind surveys can help explain fire behavior

Analysis of several wind surveys on prescribed burns revealed an increase in wind speed but no indraft ahead of fires in small canyons, contrary to what most fire fighters expect. This finding suggests that wind surveys can take a lot of the guesswork out of fire fighting by spotting tricky situations and guiding laboratory studies to develop general rules. A special survey of afternoon downslope winds was set up in a small coastal drainage in southern California. Another fireclimate study started this year will try to single out behavior patterns for Santa Ana winds.

Civil defense studies aid forest fire research

New in fire research this year are two projects with the Office of Civilian and Defense Mobilization. The "Shelter Project" seeks to determine the effect of mass fires on personnel within bomb shelters. We hope this project will help prescribe the protection needed by fire fighters and others within wildfire "safety zones". The second new project, "Diagnostic Modeling," aims to build up a detailed picture of unconfined fires that burn under given fuel and atmospheric conditions—in a sense, to catalog symptoms of fire behavior in small models much as biologists study diseases of laboratory animals to help fight human illness.

RESEARCH IN TIMBER PRODUCTION

Seed orchards to speed use of hybrid pines

To speed production of hybrid pines, the Station and the California Region of the Forest Service started work on the development of breeding orchards. The first, containing 52 strains of knobcone pine, will be used to produce seed of the fast-growing hybrid between Monterey and knobcone pines. This program represents a shift in manpower within our forest genetics research division to new studies essential for economic use of research results. Besides working with national forests in the California and Pacific Northwest Regions, the Station started new hybrid tests with the Winton Lumber Company and the Ralph L. Smith Lumber Company.

New facilities planned for forest genetics research

This drive toward commercial use of pine hybrids is bound to create new demands for information. Consequently we made preliminary plans for a substantial enlargement of the genetics program and started work on improved laboratory, greenhouse, and nursery facilities. Within a year or two we expect to be much better equipped for study of forest tree improvement problems, both at the Institute of Forest Genetics and in Berkeley. Two new arboreta were set up, one for frost-tender pine species on land made available by the University of California in Berkeley and one for cold climate or high elevation species on the Eldorado National Forest.

Chemical analysis of pine turpentine is completed

One long-term basic study was closed out during the year when analysis of the chemical composition of pine turpentines was completed for the 94th species. Besides contributing to chemical knowledge, this investigation has thrown new light on the genetic relationships among pines, their distribution, and their evolution. For his work on this project, Dr. Nicholas T. Mirov twice won national recognition this year: the Department of Agriculture's Distinguished Service Award and the Society of American Foresters' medal for outstanding contributions to biological research.

In other basic studies, we decided to concentrate on studies of pine pollen behavior in the flowering process, a segment of physiological research not conducted by the several other institutions that have begun studies of flower inducement since this project started three years ago. Studies conducted for the Station by the University of California supplied a promising method for field testing the viability of pine pollen, now a time-consuming laboratory chore, and new information on the development of flowers in pines.

Harvest cutting tests start in three timber types

In forest management research, 1958 saw the culmination of several years effort to activate experimental work in three timber types long without a comprehensive research program. Harvest cutting trials were started at:

...Challenge Experimental Forest (with Soper-Wheeler Company), in young-growth ponderosa pine on high quality site.

...Swain Mountain Experimental Forest, in the high elevation red fir-white fir type.

...Yurok Redwood Experimental Forest (with Simpson Redwood Company), in old-growth stands of redwood and associated species.

Do stored trees, like wilted collars, "lose their starch"?

Tree physiology studies turned up two promising leads as to factors affecting survival of fall lifted and stored trees. Studies with the University of California at Berkeley indicate that fall lifting should be deferred at least until November 1. In research with the California Institute of Technology at Pasadena this year, we have found that food resources in the form of starch decrease markedly during storage. The next step will be to determine if total food resources decline or if the starch is converted into other forms such as sugars.

In other forest regeneration research, a mechanical hole digger being developed by Forest Service engineers at Arcadia was field tested. Though not satisfactory in production rate, the mechanical digger resulted in higher survival of planted trees than planting with hand tools. And direct seeding trials with Douglas-fir showed a definite benefit from pretreating with endrin as a rodent repellent.

RESEARCH IN RANGE PRODUCTION

New range research program planned for foothill area

Early next year the Station will start a new long-term research program at the San Joaquin Experimental Range, which samples the immense annual-plant foothill range resource. This year we completed study plans aimed at efficient, sustained use of this range type under a year-long operation with a breeding-cow herd. Building on past findings, the new program will emphasize a search for ways to develop improved range management practices.

A large-scale trial in cooperation with a livestock permittee will compare range response to rotated and repeated seasonal continuous grazing on natural ranges and yearlong grazing on both natural and fertilized range. Smaller-scale tests will provide supplemental information on grazing practices for integrated yearlong use of fertilized

range. The Agronomy Department of the University and the Agricultural Research Service of the Department of Agriculture will continue related work. Advice in planning and carrying out studies is provided by a newly created committee of livestock operators and representatives of other land-use interests.

Forage plants gain under rest-rotation grazing system

Evidence that research-based range management systems can improve rangeland continued to show up at a pilot-plant study in northeastern California. A rest-rotation management system is being tested on the Lassen National Forest's Harvey Valley grazing allotment. There, new forage plants appeared in goodly numbers on range sites managed specifically to yield seedlings this year; older seedlings are taking hold and adding to grazing capacity; and artificially seeded grasses have thickened under the grazing system. This improvement was realized without reducing the 500 animal-units of grazing on the allotment, and the cattle—furnished by Roney Bros., the cooperating livestock operators—gained about 2 pounds per head each day of the 4-month grazing season.

Field study of bitterbrush ecology is completed

Two years ago we set out to learn the ecological facts of life about bitterbrush, one of the most valuable browse plants on big game winter ranges. This year the field phase of this study was completed. We know that we have two species to deal with in California. One of them, desert bitterbrush, grows in middle elevations between the deserts and high mountains in southern California. The other, antelope bitterbrush, grows in the northeastern plateau. The two overlap and hybridize in east central California around Mono Lake. For the two typical forms, enough information on soil, site, and growth requirements is at hand for a successful revegetation program. Another segment of this game-browse study has shown how to plant bitterbrush, and workers at the Susanville Research Center are now concentrating on development of more economical methods for this species and on a search for planting methods for other browse species.

Deer habitat analysis reveals research needs

Also completed this year is the analysis of deer-habitat management problems in northern California. Two critical needs for improved habitat management were revealed by this analysis: for westside Sierra timber sites used by deer in winter, and for low elevation brushlands on the west side now heavily used by deer in winter. Most high Cascade and Sierra summer deer ranges in California are somewhat deteriorated and generally too heavily stocked. The relative effects of summer and winter range conditions on deer and their welfare during winter are little known. The analysis, to be published soon, will serve as the basis for future research; it recommends a multiple-use approach to habitat research—an approach that so far has had relatively little trial.

RESEARCH IN WATER PRODUCTION

"Face lifting" starts in southern California pilot watershed study

Southern California's major watershed study gave the Big Dalton watershed on the San Dimas Experimental Forest quite a face lifting in 1958. Alders, oaks, sycamore, maple, willow, and related "water hogs" are giving way to the axe and chemicals in the Monroe Canyon stream bottom. In nearby Bell Canyon, again to see if we can make watersheds produce more good water, a helicopter pilot sprayed chemicals on the chaparral on side slopes with deep soils. Expansion of the Fuel-Break project will provide an opportunity to extend application of this pilot study and other research in southern California by combining water yield objectives and hazard reduction objectives of the Station's southern California research program.

New research tools aid watershed management studies

New work started this year in cooperation with the California Division of Forestry includes:

- ...a field study to measure the amount of rainfall that grass intercepts and returns to the atmosphere through evaporation.
- ...more and better measurements of soil moisture and the use of water by plants in southern California mountains through use of the nuclear soil-moisture probe.
- ...development of a device for temporarily incasing all or part of a plant and obtaining a measurement of transpiration, which up to now has usually been measured by less direct methods.

Snowpack studies measure water losses

Snow management research, started two years ago with the California Department of Water Resources, has now hit its stride. One study is completed and 17 others are underway. One of these is beginning to yield information on how snow (and snow water) is evaporated and lost. First-year measurements of water losses showed:

Summer losses of soil moisture from densely forested south slopes amounted to 5.3 inches; from bare south sloped, 4.8 inches; from densely forested north slopes, 4.8 inches; and from bare north slopes, 3.0 inches.

Snow intercepted and evaporated from the tree crowns during March and April averaged 8.6 percent of the precipitation.

Winter evaporation from the snowpack in large open areas totaled 2.3 inches; from small forest openings, 0.2 inches. Under dense forest, however, condensation actually exceeded evaporation—the snowpack gained 2.1 inches of water.

How to delay snowpack melt: A first hint

These water-loss findings coupled with early measurements of the snowpack in snow-survey courses on 60 forest sites suggest that--to delay water yield forest managers should try to:

1. Cause snow to drift into areas where the trees or topography shade the snowpack
2. Trap cold air on these drifts to retard melt.
3. Reduce back radiation from the trees to the snow.
4. And, reduce interception loss.

These objectives will probably require a complex pattern of strip cutting. Tentatively, we can reason that the strips should be one to two tree heights in width—oriented east to west on north-facing slopes and level areas, northwest to southeast on south slopes. West and east slopes will probably need L-shaped openings—with one strip running along the slope as a cold air trap and the other extending up slope as a cold air source. Successive cuttings should progress southward to create a "wall and step" forest with the wall to the south. It is still too early to define the cutting pattern precisely or to say what it will buy in water yield.

RESEARCH IN ECONOMICS AND UTILIZATION

Log and tree grade research started in ponderosa pine

Can you spot the lumber grades or dollar values in a standing tree or a recently harvested log? The answer to this question and the standards for judging timber quality vary from place to place. The lack of uniform standards hinders progress in managing, marketing, and utilizing timber resources. This year the Station helped plan a nationwide research program that will develop standardized systems of log and tree grades, and we have been assigned responsibility for the Ponderosa Pine Project—the first in the new program.

Under the guidance of the Forest Service's research branch, this interregional project will draw on the staffs of public and industrial agencies throughout the West. Besides ponderosa pine, it will consider several associated species: sugar pine, western white pine, Jeffrey pine, lodgepole pine, white fir, and Engelmann spruce. To speed analysis of research data, the project leader is developing electronic computer programs; they will be used first for analysis of lumber recovery data already collected at more than 50 western sawmills.

New sampling method tested in surveys of California and Hawaii

A new sampling method—designed to provide a continuous inventory of timber resources—went into operation this year as field crews gathered data for forest surveys of California and Hawaii. The first survey of California sampled a part of the region each year and then added the parts for

regionwide figures. The resurvey will take a partial sample of the entire region each year, building an increasingly accurate picture of changes in timber area, volume, and growth since the first survey. Within a few years we will be able to make current estimates for California at any given time. This year field work was concentrated in southern California to complete "de-bugging" of the sampling method. In Hawaii, where the Territory's first forest survey got underway, the sampling approach had to be modified to provide base figures for a continuous inventory. There the work will progress island by island in the first go round.

Soil-vegetation survey moves into Shasta County

Field crews working on the cooperative soil-vegetation survey completed their jobs in Tehama County this year and began mapping in Shasta County. Plans completed with the California Division of Forestry will allow us to step up the rate of mapping next year by about 15 percent with no increase in funds. The project published quadrangle maps for about 750,000 acres previously surveyed. Among the completed maps is one for the Big Creek Pilot Area, where the California Region of the Forest Service will use the survey information to work out problems in land use and management.

Hawaiian woods show promise for industrial use

Work with the Territory of Hawaii was expanded to include a survey of forest products utilization possibilities in the Islands. The first-hand study of local problems supplements work that the U. S. Forest Products Laboratory has been doing for several years in evaluating the properties of the wood of introduced species. Some of these trees, we found, can grow high quality timber in a relatively short time. They offer a good opportunity to establish a sound forest management and utilization program.

Lab studies seek broader uses for California woods

Studies with the U. S. Forest Products Laboratory are seeking ways to broaden the industrial base, heretofore geared largely to lumber production. Work on pulping of local softwoods and hardwoods, and studies of ways to vary pulp blends for different types of paper, promise additional uses of wood fiber. Experimental work also showed that some local hardwoods—madrone and tanoak, especially—have distinct value for sliced veneer. Several years ago the Laboratory found that these woods were suitable for rotary cut veneers.

New information for the lumber industry will come from a study completed this year in cooperation with the University of California Forest Products Laboratory and local dry-kiln clubs. This 18-month study gathered data on the moisture content of wood in buildings throughout northern California. It will enable lumber manufacturers and fabricators to dry wood products to moisture contents that correspond to use conditions.

COOPERATION IN WILDLAND RESEARCH

Cooperation in wildland research has a long history in California. The Forest Service and the State Board of Forestry were cooperating in a study of reforestation methods as early as 1904. They worked together on many other projects through the years, and the beginning of comprehensive research by the Station stems from action of the State Legislature.

In 1923, as Deputy State Forester R. C. Clar has reported, the legislature urged Congress to establish a forest experiment station in California. The Legislature later authorized the use of state funds to supplement the federal budget, and in 1927—the year after the Station was set up at Berkeley—the state budget included $20,000 for studies by the Station. Many times since then the Station's nine research divisions have pooled their resources with those of a state agency to make faster progress toward solving problems of mutual concern to the state and the nation.

The University of California has been an active partner with the Station since 1926. The University has provided quarters for our Berkeley staff, and the two organizations have collaborated in many research and educational programs. Because growing educational needs have crowded the Berkeley campus, we are now preparing our own off-campus quarters. Nevertheless, the close collaboration of Station research divisions and University departments will continue.

Others have had a hand in the development of our wildland research program: privately endowed foundations, universities, timber growers and manufacturers, other industries, and local government agencies. Mostly these have been short-term projects; some are still active. Some are merely informal agreements by staff members of two agencies to pitch in materials or facilities for solution of a difficult problem; others are set up as separate projects under formal cooperative agreement.

Station staff members were working informally on more than a dozen joint studies with the University of California in 1958. They were tackling such questions as:

...What are the chief sources of erosion debris?
...How can we improve seasoning of black oak lumber?
...What insects destroy forest tree seed?
...How does microclimate affect spread of blister rust?
...What are the best chemicals for brush control work?

This close collaboration extends to the classroom—the Station helps graduate students collect data for research problems, conducts lectures and tours of field laboratories, and employs about 25 students each year in seasonal or part-time jobs. And, cooperative efforts reach out beyond the Berkeley campus; for example: a professor at Los Angeles is helping us with soil moisture studies at San Dimas Experimental Forest, agronomists at Davis conduct some of their field studies at the San Joaquin Experimental Range, our fire research division is using laboratory space at the University's Engineering Field Station at Richmond.

Many other agencies are working with the Station under informal letters of understanding—too many, in fact, to single out here. In forest genetics research alone, more than a hundred cooperators are helping test the adaptability of pine hybrids to varied growing conditions: 5 city and county agencies, 12 state agencies, 18 universities, 37 private individuals and companies, and 34 foreign countries. All these informal cooperative studies contribute a valuable insight into the research needs of many commercial and academic institutions.

Formal cooperative projects at the Station now total 38. Many involve two or more cooperators; we are working with state governmental agencies, chiefly the Division of Forestry, on 15 projects, with city and county government on 6, with the University of California on 15, with other universities on 5, with private or public foundations on 4, with private industry on 7, and with other federal agencies on 7. In some we have granted funds to agencies especially suited for a specific job; in others, we are receiving financial support or technical help from cooperating agencies. There follows a summary of these projects.

FOREST PEST SURVEYS

The Problem

Inroads made by forest insects and diseases are a major deterrent to successful management of wildland resources in California. If we are to improve protection of existing resources, put lands that are now non-productive into use, and increase the productivity of lands now under partial management, damage must be reduced. Surveys of forest pest conditions are needed to uncover dangerous outbreaks in their early stages so that control measures can be promptly applied.

The Approach

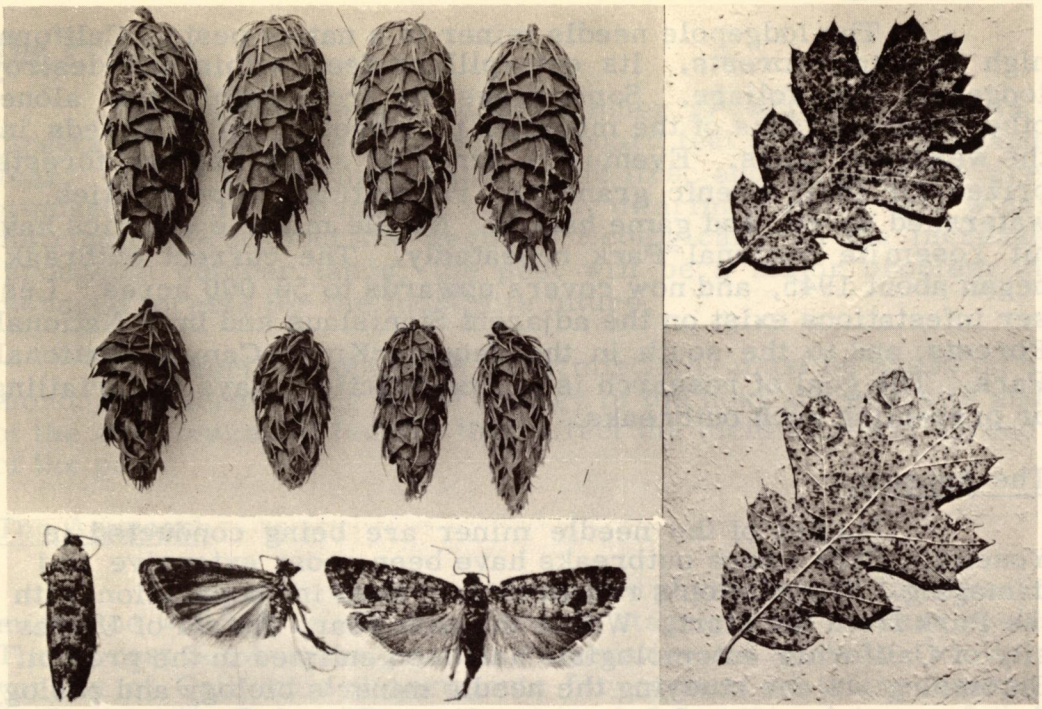
The annual cooperative forest insect and disease survey encompasses the entire forested area of the State. Spearheaded by the Station, the survey is aided by representatives of 10 private industry, state, and federal organizations, which make up the California Forest Pest Control Action Council. Cooperators report suspicious or unusual pest conditions, assist in ground and aerial appraisals of damage, and help to disseminate the findings. Station entomologists and pathologists screen detection reports, determine the potentialities of the pest involved, and if necessary make a follow-up appraisal of the situation on the ground, with the help of the land manager.

Where We Stand

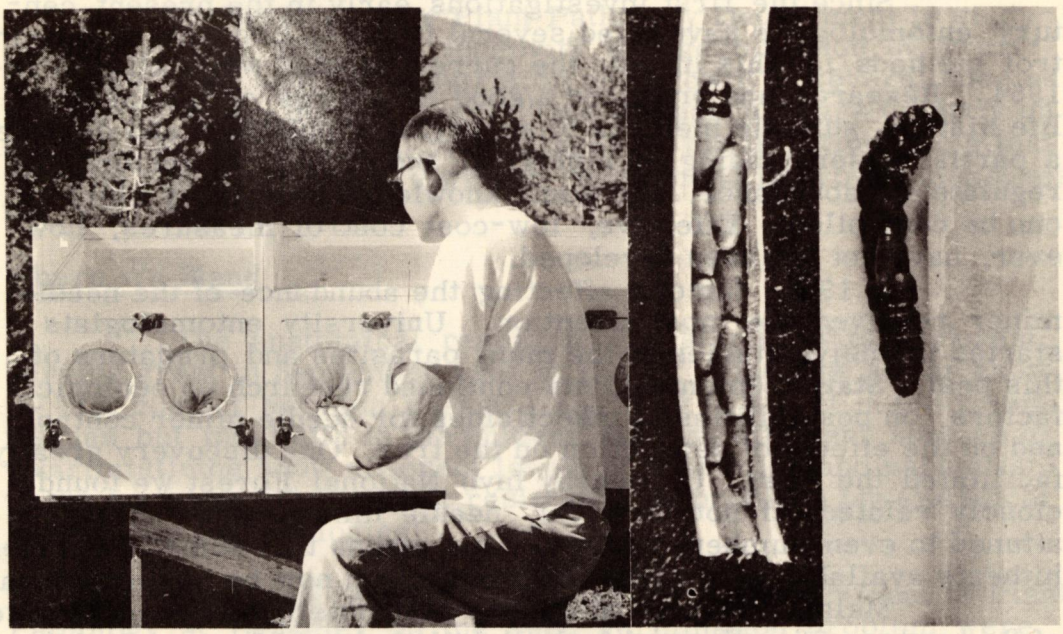
Surveys of current or potential pest outbreaks have been strengthened and improved considerably since their inception in 1949. Even so, coverage is only intensive enough to spot the worst outbreaks of pests likely to kill mature and overmature trees. Neither the overall annual damage to the present timber crop nor losses to the potential timber crop, including the seed supply, young seedlings, and growing stock, are being measured, but plans are being made to overcome these deficiencies as rapidly as funds and manpower permit.

In 1958, the cooperative detection survey yielded 213 reports of insect damage. Except in some localities, bark beetle damage in timber producing forests was below normal. Mountain pine beetle was epidemic in lodgepole pine in many parts of the state. The lodgepole needle miner continued in outbreak in the east central Sierra. Cone and seed insect damage was very high, and a variety of pests continued to take their toll of plantations. Insects like the Great Basin tent caterpillar and other as yet unknown species were very destructive to game browse and woody range plants.

To accelerate the disease survey, we devised and put into operation this year a new sampling procedure using random temporary plots rather than permanent plots. Each year's survey results will be accumulative for machine compilation and analysis. With this system, the survey party checked three times as many plots as last year. Nearly half the plots had trees infected by dwarfmistletoe; heart rots were noted on 85 percent of the sample plots. Outbreaks of foliage diseases on hardwoods were especially severe.



Top left, Douglas-fir cones protected from insect attack by lumite bags; unprotected cones below were heavily infested by the Douglas-fir cone moth (inset). At right, black oak leaves infected with leaf blight.



Left, sleeve-type cages used in rearing parasites of lodgepole needle miner; center, hollowed pine needle containing miner larva attacked by multiple internal parasite; right, external parasite attached to larva.

BIOLOGY AND CONTROL OF THE LODGEPOLE NEEDLE MINER

The Problem

The lodgepole needle miner is a native pest of California's high mountain forests. Its caterpillars feed within and destroy lodgepole pine foliage. Some trees die from defoliation alone; others from attacks of the mountain pine beetle, which breeds in the weakened trees. Eventually acres of snags replace forests prized for their scenic grandeur, recreational opportunities, watershed cover, and game habitat. Needle miner epidemics have hit Yosemite National Park repeatedly. The current outbreak began about 1945, and now covers upwards to 50,000 acres. Lesser infestations exist on the adjacent Stanislaus and Inyo National Forests, and to the south in the Sequoia-Kings Canyon National Park. The goal of research is to find practical ways of curtailing or preventing such outbreaks.

The Approach

Studies of the needle miner are being conducted in Yosemite Park where outbreaks have been most extensive and damaging. The Station's research has been in cooperation with the Park from the start. Within the past year, the aid of University of California entomologists has been enlisted in the project. Entomologists are studying the needle miner's biology and ecology, the nature and extent of damage, and natural and artificial methods of control. Facilities for seasonal field work, headquartered at Tuolumne Meadows, are furnished by the Park.

Where We Stand

Since the first investigations early in the present century, entomologists have tried several times to find workable control methods for this insect; the current studies were started in 1954. Research has produced a good knowledge of the insect's life history, suitable methods of surveying populations and damage, a partial understanding of biological and ecological factors that regulate its abundance, and some knowledge of ways by which it can be controlled. Effective, low-cost control measures, however, have not yet been developed.

In 1958, factors affecting the abundance of the needle miner received the most attention. University entomologists started intensive studies of the many parasites and predators of this pest. Station entomologists continued research on ecological factors, on possibilities of insecticides for needle miner control, and on the effects of defoliation on the tree. One discovery greatly facilitated the work: On nearby Inyo National Forest we found a closely related, if not identical, needle miner with a life cycle attuned to even-numbered years. This means that some life stages, hitherto available only every other year, can now be studied annually.

Malathion spray applied by helicopter at a per-acre rate of 2 pounds in 20 gallons of fuel oil killed about 75 percent of the insects in tests last year against the moths and newly hatched larvae. Against young larvae inside the needles in June, the spray was about half as effective. Where three-fourths of the insects were killed, defoliation was only about one-third as severe as in comparable unsprayed stands.

ANATOMY AND PHYSIOLOGY OF DWARFMISTLETOE

The Problem

Dwarfmistletoes reduce timber growth in California forests by an estimated 153 million-board feet of sawtimber each year. All of California's pines, true firs, and Douglas-fir are attacked and are damaged or killed by dwarfmistletoes, now widely distributed throughout the region. Ecologically on the increase throughout cutover lands, the pest will be a major problem in managed forests for the indefinite future.

Effective control of dwarfmistletoe must be based on a thorough understanding of the biology of the host and parasite and of the environmental factors that affect the incidence and spread of the pest.

The Approach

Research on the anatomy and physiology of the dwarfmistletoe will tell us about vulnerable stages in the disease cycle. The Forest Service has granted cooperative aid funds to two University of California departments for conduct of this research. At Davis, the Botany Department is studying the anatomy of the dwarfmistletoe. A measure of the impact of the parasite on the structure and metabolism of host trees will be obtained by comparing infected and uninfected hosts. Several species and forms of both host and parasite are being studied.

At Berkeley, the Plant Pathology Department is studying factors that affect the longevity and germination of dwarfmistletoe seed and the penetration and growth of several species and forms within the host tree. This research bears directly on the critical and essential first stages of the infection cycle that must be understood before we can recommend improved measures for control.

Where We Stand

The anatomical research was started with a Forest Service grant in September 1957 at Davis. Findings so far show: (1) that contact between parasite and host is direct in the xylem tissues but indefinite in the phloem; (2) that different species of dwarfmistletoe show different levels of adaptation and parasitism to the host; and (3) that host resistance is probably physiological rather than morphological.

Field and laboratory studies by the Department of Plant Pathology at Berkeley on the seed germination problem were started in 1957. These and supporting studies were given impetus by the allotment of cooperative aid funds by the Forest Service in October 1958. No results are available as yet from these studies.

DEVELOPMENT OF BLISTER RUST RESISTANT SUGAR PINES

The Problem

Sugar pine, one of the West's most valuable timber species, is highly susceptible to the white pine blister rust disease. Can we simplify the control job by producing seed and planting stock of sugar pine more resistant to the disease than wild stock?

The Approach

Federal, state, university, and private forest managers and researchers have prepared a 10-year research program to answer this question. They are working on:

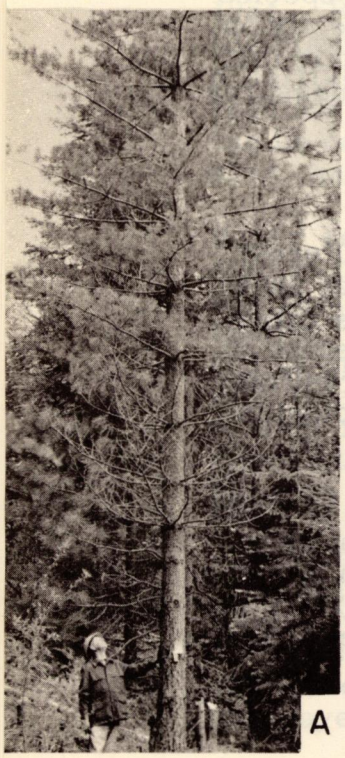
- ...an intensive search for resistant trees.
- ...protecting certified candidate trees.
- ...propagating and testing individual clones and hybrids to prove their capacity to resist the rust and to transmit resistance.
- ...setting up test outplanting sites both as archive plantations and as seed orchards.

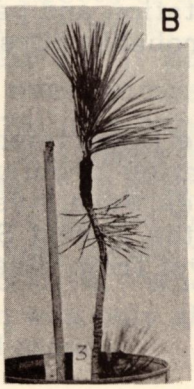
The sugar pine program is being coordinated with similar work on western white pine in Oregon, Washington, and Idaho.

Where We Stand

From 1951 to 1956 project leaders in blister rust control searched the heavy rust centers of northern California for resistant sugar pine. Intensive and systematic survey for candidate trees was started in 1957 and continued in 1958 by a 2-man survey party from the Klamath National Forest. From all surveys we have now located 80 trees that qualify for propagation and testing. Some of these trees have been released, fertilized, and given special protection.

Sugar pine stock for grafting has been supplied by the California State Forest Nursery at Magalia. Grafting work was started at Berkeley in 1957 (250 grafts) and continued in 1958 (325 grafts). We have tested different types and age of scions and stocks and various grafting techniques. Immediate success of grafts has been good; extended survival and growth has been mediocre.





A. Rust-resistant candidate sugar pine tree released and fertilized.

Grafts from candidate trees:
B. tip cleft graft
C. bottle graft

FIRE DANGER RATING

The Problem

Fire danger is a comprehensive term. It includes everything that affects burning and all that fires can do. Essentially, total fire danger is the damage potential from fire in any area. Fire danger rating, then, is a numerical rating of this potential as it varies in time and space—in short, the measure of fire-control needs. Theoretically it would be possible to construct a fire danger index that will take all of the factors making up total fire danger into account. In reality it is not practical or even desirable to do so. Computation of such a number would be too cumbersome and its interpretation too difficult to be of any use as a day-to-day fire control tool. Can we develop separate indexes for each of the factors affecting total fire danger and then set up procedures whereby these indexes, either individually or in combinations can be used as guides to action in fire control?

The Approach

The effect of weather on the inception and behavior of fire was selected for first attack in developing fire danger ratings. Three indexes are involved:

1. Rate of spread index
2. Fire intensity index
3. Ignition probability index

This work is conducted in cooperation with the California Division of Forestry and the U. S. Weather Bureau, with the financial support of the Division of Forestry.

Where We Stand

Started in 1955, the project developed a pilot model of a new rating system combining both intensity and rate of spread; in 1957 this system was subjected to a series of field tests in areas protected by the Division of Forestry and the Forest Service.

In 1958, the combined Burning Index was put into full-scale operational use by all fire control agencies in the state to guide both presuppression and suppression activities. Compilation of data for the development of an ignition probability index was started.

ESTABLISHING AND MAINTAINING BREAKS IN CONTINUOUS FUEL TYPES

The Problem

When weather conditions are extreme, fires too often defy fire-control efforts in California's steep mountains and dense stands of highly flammable fuels. We have few prospects of controlling weather conditions. Can we develop ways to break up or change expanses of fuel so fire control will be less difficult during severe weather?

The Approach

The Station has set up project Fuel-Break in southern California, where dense chaparral is a particularly difficult fuel type; this long-term study is planned so its results can be applied to other parts of California or the United States. The California Division of Forestry, Los Padres, Angeles, San Bernardino, Cleveland, and Mendocino National Forests, Los Angeles County Fire Department, University of California, and other agencies are contributing manpower and equipment. The project is guided by an executive committee representing the cooperating agencies.

The plan is to test chemical and other methods of controlling plant growth, measure the effect of cover changes on fire behavior and control, and work out practical application of the research results. These applications will need to be carefully integrated with wildland management for water, timber, forage, and other resource values.

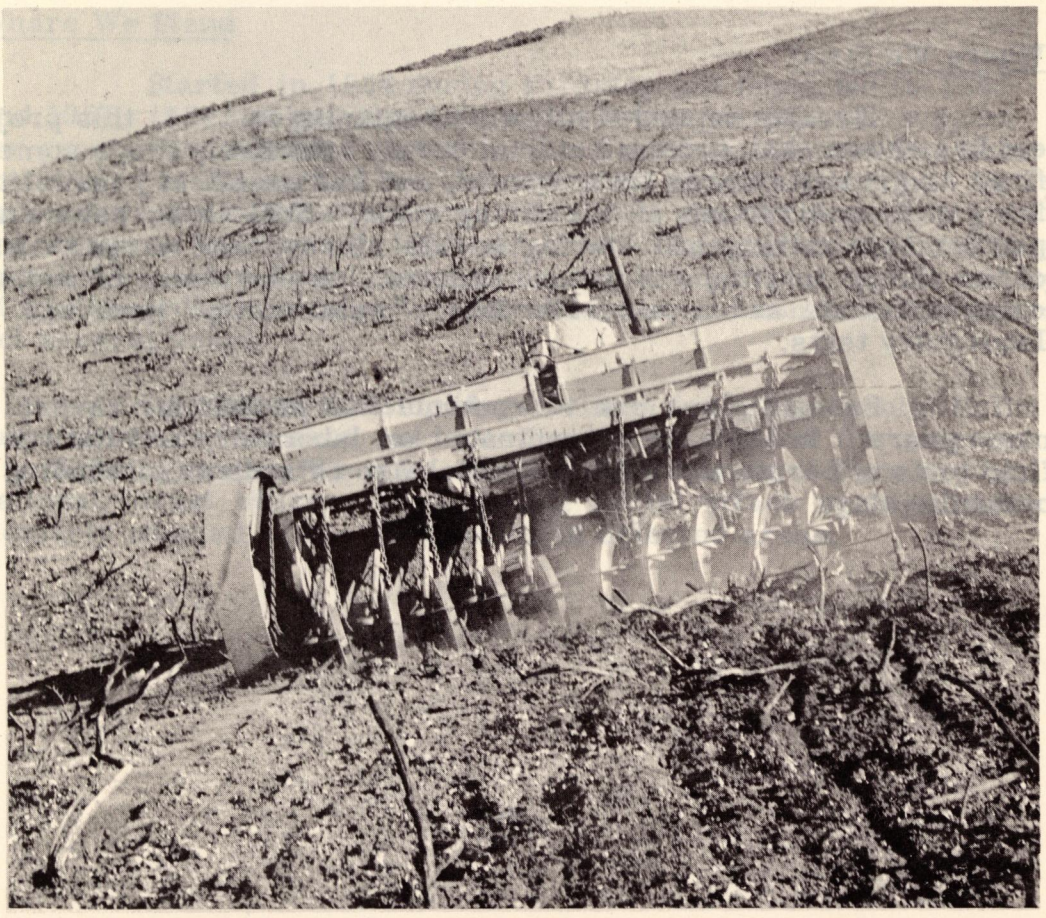
Where We Stand

After the first meeting of the executive committee in November 1957, held to organize and lay plans for the future, the project leader and his assistants made an extensive survey of brush control problems on cleared firebreaks in southern California. After the survey they sent available information on the use of chemicals to field men, and large-scale tests were begun. In addition, they started some experimental trials of brush-control techniques on hard-to-kill species, using hormone-type chemicals applied at various dates.

In 1958, application of current knowledge was started on wildfire burns and previously cleared firebreaks, where helicopters, tractors, and other units applied hormone sprays to about 260 acres of sprouting brush. Chemical-control test plots were set out on land protected by the Forest Service and the Division of Forestry. Some plants reported to have fire- and drought-resistant qualities were planted for future trials as substitutes for highly flammable species in chaparral. Basic fuel studies were also started this year to augment knowledge of burning conditions in different cover types.

Broadcast spraying of chemicals for brush control. Helicopters are used when land is too steep or rocky for ground equipment.

After clearing, heavy brush fuels are replaced by grasses or other cover types.



EVALUATION OF FOREST FIRE RETARDANTS

The Problem

Forest fire retardants, first tested during Operation Firestop in 1954, are being adopted widely for use in wildland fire control even though a good many problems are encountered in the use and handling of these materials. Also, fire fighters need to know more about the limits of retardant performance and the requirements for their most effective use.

The Approach

The project has three broad phases. Best known of these three are the field tests and demonstrations with air tankers, which include experiments on test plots and wildfires to determine amount of coverage in different fuel types. A second phase is measuring the effect of retardants on the spread of fire in different fuel types and densities. The third is screening various fire retardants in laboratory and field tests. Region 5 and the California Division of Forestry are working with the Station by furnishing equipment, technical help, and field personnel as needed on special tests and demonstrations.

Where We Stand

Steadily expanded since its beginning in 1954, this project has shown that sodium calcium borate effectively stops some fires or greatly retards their spread, and has excellent possibilities for rapid construction of backfiring lines. Still to be solved are problems in mixing and storing borate slurry, and abrasiveness of the slurry in pumps of ground tankers. A new form of sodium calcium borate and a new retardant, "water-cote," have had laboratory tests.

Present plans are to continue this project for several more years. In 1958 we concentrated on laboratory and limited field tests of borate and other potential fire retardants, including bentonite clay.

TACTICAL AIR SUPPORT ON FOREST FIRES

The Problem

We all have seen much evidence in recent years that aircraft can play a greater role in fire fighting. To speed this development, this project is devising and field testing methods of tactical air support for fires in grass, brush, and timber. As the methods are improved, the project also aims to work out principles for integrating air attack into existing fire organizations.

The Approach

Aided by personnel and equipment of Region 5 national forests, the California Division of Forestry, and the Los Angeles County Fire Department, the Station is studying tactical air support along four main lines of investigation: (1) Measuring on wildfires the effectiveness of water and chemicals dropped from air tankers. (2) Preparing preliminary training guides for Helitack crews. (3) Integrating Helitack activities with ground operations, as in laying hose lines. (4) Evaluating the types of organization needed to control aircraft operations.

Where We Stand

Started in 1954 during Firestop and expanded in 1956 and 1957, this project has left no doubt that tactical air support for ground fire fighters is practical. Use of air tankers has been introduced to the rest of the United States. Specially trained Helitack crews and new helicopter accessories also were used to good advantage on wildfires in 1957 and 1958. These advances have been speeded by several publications, short training films, and a variety of on-the-ground demonstrations. Plans are to continue this project several years.

In 1958 we developed guidelines for using special Helitack crews and worked out specific Helitack plans for selected fire-fighting units. We also assisted the Division of Forestry and national-forest officers in designing initial-attack systems particularly adapted to use air tankers in selected areas.

HELITACK

The Problem

Helicopters have been used by fire-fighting agencies in California since 1947, mostly for reconnaissance and transportation of men and equipment. The mobility of this aircraft suggested that it could play a larger role in direct attack. Could new fire-fighting accessories and specially trained crews make fuller use of the helicopter's potentialities for direct attack while fires are small?

The Approach

To seek an answer, the Helitack project was organized as a joint program of the Forest Service, the California Division of Forestry, the Los Angeles County Fire Department, and the U. S. Army. A key element in this program was to develop effective Helitack crews under a student aid grant from the Station to Utah State University. It set out to:

...develop a training program for specially equipped helicopter crews that could be used by any wildland administrative unit.

...prepare a plan for integrating helicopters and crews into national-forest fire-fighting units.

...develop jump techniques for situations where a helicopter cannot land.

Where We Stand

The project started in 1956. By the next year a preliminary training plan was developed and tested on some 300 firefighter trainees in California. Job specifications were prepared for all positions in the Helitack crew. Specifications for a protective jump suit were also prepared in 1957.

In 1958 the jump suit was tested with mannequins dropped from a helicopter over different types of brush and terrain. Instructions for the Helitack jump were prepared. A revised training plan was given additional trials on national forests in the Intermountain and California Regions. A detailed study of Helitack operations on two national forests was completed and the results incorporated in a plan for integrating helicopters and Helitack crews into the fire-fighting organization of federal, state, or local agencies.

Work will continue on development of new fire control accessories and evaluation of specially trained crews for initial attack and follow-up on wildfires.

Mannequin dropped from hovering helicopter to test protective clothing for use by helitack crews.

FIRECLIMATE SURVEYS

The Problem

For most effective fire control with the greatest safety to men and equipment, fire fighters need an accurate picture of local fireclimate patterns, especially the winds that will accompany particular weather situations at any time. The existing system of fire weather stations is not adequate to define these patterns and their relation to general weather patterns.

The Approach

In cooperation with the California Division of Forestry, the Station is trying to learn how fire itself affects fireclimate patterns and to identify the situations that must be studied to establish basic relationships between local fireclimate and general weather conditions, topography, and fire. The program includes:

- ... short-term fireclimate surveys before and during prescribed burns.
- ... short-term surveys of specific problems, such as Santa Ana winds.
- ... longer-term surveys in which distinctive topographic types are studied intensively.

Study areas are provided with a network of recording weather instruments, and data are collected continuously during the study period.

Where We Stand

Started during Operation Firestop in 1954, the fireclimate survey program was intensified in Arroyo Seco drainage in 1956 and continued there in 1957. Four prescribed burns were studied in 1957.

In 1958, data accumulated from the prescribed burns were analyzed. Fire behavior on the burns followed closely that to be expected from the wind patterns determined in the survey. This would indicate that such surveys have great immediate and practical value in effectively and safely conducting prescribed burns. The surveys have also shown that downslope winds beginning in the early afternoon on east-facing slopes may be far more common than previously supposed. A special study of daytime downslope winds was made in De Luz Canyon, San Diego County; data from this 3-week survey are being analyzed. Tabulation of the large mass of data accumulated by the Station in the Arroyo Seco fireclimate survey has been completed: the data are on 43,000 punch cards and analysis is underway. Study of Santa Ana wind conditions, started on the Arroyo Seco survey in 1957, was intensified through installation of a new network of recording instruments on the Baldy District of Angeles National Forest.

INVASION OF MARINE AIR INTO SOUTHERN CALIFORNIA MOUNTAINS

The Problem

One of the major controls of the fireclimate in southern California is the marine air common to this area. The invasion and recession of this relatively cool, moist air in the coastal mountains affects both the inception and the behavior of wildland fires. The movement of this air is a well known phenomenon but little quantitative information is available concerning the magnitude of the movement of this air into the mountain drainages, its duration, and its effect on wind and other fireclimate patterns.

The Approach

As part of the Station's fireclimate survey in the Arroyo Seco drainage, the Forest Service granted cooperative aid funds to a graduate student in meteorology at the University of California. His assignment was to:

... determine from detailed measurements of surface weather and upper air conditions the extent of the invasion of marine air and its effects on fire weather.

... correlate marine air invasion and recession with general weather conditions.

Where We Stand

Begun in 1956, field work and data analysis for this project were completed in 1958. A major contribution of this study was a better understanding of the relation of the well known "Catalina Eddy" circulation and the influx of marine air into the mountains of southern California. Marked changes in the fireclimate pattern in the Arroyo Seco were observed under certain conditions of this circulation. The study also added materially to our knowledge of the Catalina Eddy circulation itself and its relation to the larger scale circulations that bring marine air into the mountains or cause it to recede. Results of the study are being prepared for publication.

OPERATIONS ANALYSIS OF INITIAL ATTACK

The Problem

Much progress has been made by fire agencies in development of efficient fire-control action, but failure to stop fires upon initial attack by fire fighters still costs millions of dollars each year. In addition, new air and chemical attack techniques need to be integrated into conventional fire-fighting systems. Fire fighters need better guidelines for initial attack on wildfires with both conventional and new techniques.

The Approach

The project is using operations research techniques developed since World War II to guide military and industrial actions. Operations research approaches management problems by setting up mathematical models which it verifies by experimental tests. It then uses these models to predict operational behavior and to redesign the operations for optimum efficiency. A Station mathematician was assigned to this work in cooperation with Region 5 national forests, the California Division of Forestry, Los Angeles County Fire Department, and the University of California at Los Angeles.

Where We Stand

Started in 1957, this is a pioneer venture in applying operations analysis to forestry problems, and we are planning a continuing project. For the first year, the project worker concentrated on getting better acquainted with operations research procedures at research and development institutions in southern California.

In 1958 we conducted exploratory studies in the development of guidelines for dispatching air tankers to forest fires. Also, we assigned the operations research trainee to southern California fire-fighting crews for extended periods to permit him to begin laying the groundwork for preparation of a problem analysis of initial attack systems. Under new congressional authorization, he is now attending the University of California at Los Angeles to gain a better understanding of the operations analysis techniques.

FIRE PREVENTION RESEARCH

The Problem

The evaluation of human risk is of the utmost importance to a balanced and effective fire prevention program. Our present program may be entirely misdirected if it does not reach the people responsible for setting the majority of fires. Even more important, a prevention campaign which assumes that forest fires are caused through ignorance is bound to fail if most fires are in fact caused by indifference to the values at stake or by a lack of moral responsibility for community property.

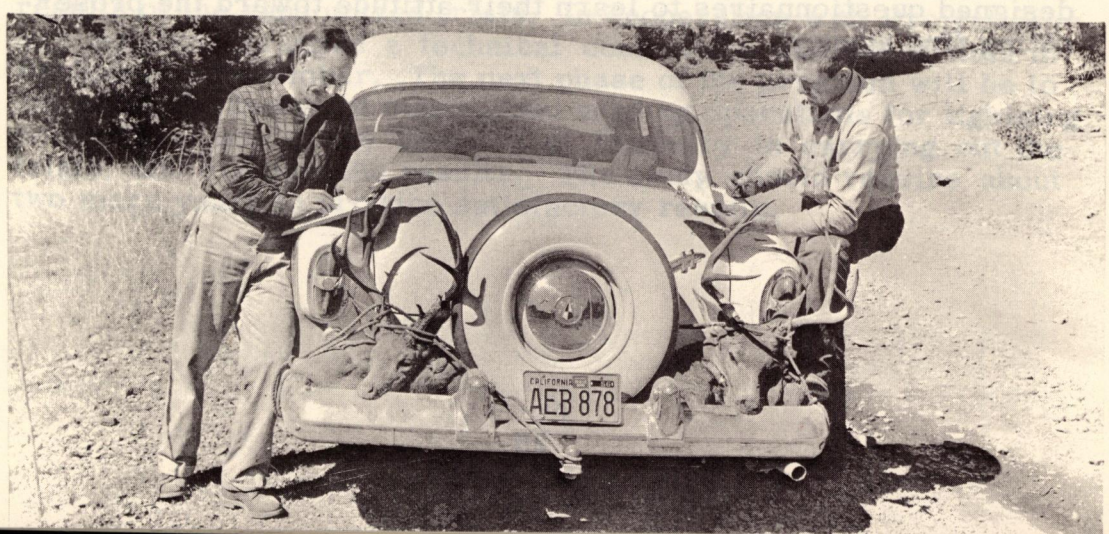
The Approach

A study of this problem, then, must lean heavily on the techniques of psychological and opinion-survey investigations. Preliminary work is concentrating on developing a sound research approach through study of the public's knowledge of fire prevention rules and regulations. The research has been contracted to specialists at the University of Southern California, who work under the guidance of the Station, with financial support shared by the California Division of Forestry and Region 5 of the Forest Service.

Where We Stand

Since the start of this project in 1957, the research team has designed a preliminary series of questionnaires to test the fire prevention knowledge of campers, fishermen, and forest residents on national-forest areas; field-tested the questionnaires on three national forests; and revised them to meet the special problems of the California Division of Forestry in dealing with the residents of wildland areas.

In 1958, research workers started testing the validity of questionnaires so we can sample the knowledge of forest users on both national forest and state-protected lands. Deer hunters were among the first to receive a test of fire prevention knowledge. Next, we propose to determine the "norms" of opinions and attitudes among different segments of the population. Determining these norms is a necessary step in providing a yardstick against which we can measure the effectiveness of different approaches to fire-prevention education.



PSYCHOLOGICAL EFFECTS OF FIRE LAW ENFORCEMENT

The Problem

One of the stated goals of fire law enforcement is fire prevention, but opinions on the effectiveness of law enforcement vary widely. Some foresters say that strict prosecution of all violations is the most effective way to reduce man-caused fires. Others say that lenient law enforcement tempered with common sense is the best prevention method. As a result, there is a wide variation in law enforcement practices, not only among different fire agencies, but within organizations. Employees are confused, and so is the public.

The Approach

Before we can provide sound guidelines to foresters, we need to find some way to measure the psychological effects of law enforcement. To do this, the Forest Service has granted cooperative student aid funds to a graduate student in psychology at the University of Southern California who is also a lieutenant in the Los Angeles Police Department. His job is to develop a practical research design and obtain a measure of its validity and reliability.

Where We Stand

This project was begun in 1958. Drawing on experience of the San Bernardino and Angeles National Forests, the officer has designed a research plan and is now working closely with the local national-forest staff in classifying the people who have violated forest fire laws. Next step will be to administer specially-designed questionnaires to learn their attitude toward the prosecuting fire agency.

EVALUATION OF CLOUD SEEDING FOR CONTROL OF LIGHTNING

The Problem

Will cloud seeding modify thunderstorms in such a way that it will reduce or prevent lightning fires? There is strong evidence that clouds can be modified by seeding, but one difficulty in these meteorological experiments is to know whether the outcome is due more to the chance vagaries of weather than to the experimental operation.

The Approach

An important element of this project, therefore, is to design mathematically sound experiments and methods of evaluation. With the financial support of the California Division of Forestry, the Station has assigned a meteorologist to work out these techniques. Because there is still much to learn about thunderstorm activity in the mountains, this project is maintaining close liaison with Project Skyfire in Montana, a basic research project of the Forest Service and the Weather Bureau. A third aspect of the work is a survey of equipment and methods for measuring the movement and severity of lightning strokes.

Where We Stand

Work on experimental design was started in July 1957. Two tests were conducted that summer, one using ground burners to release silver iodide crystals into cumulus clouds in northeastern California, the other using airplanes in the North Coast region. Results of these trials provided information needed to design a randomized seeding procedure.

In 1958 we helped the Division of Forestry design a test area in northeastern California, and started evaluation of the results of the randomized trials. In cooperation with Project Skyfire we also arranged a technical conference which was held in Berkeley in December. The next phase of the program will be to complete the design of other cloud seeding operations for lightning prevention, assist the Division of Forestry in carrying out the trials, and evaluate the results. The study should require about two more years to produce satisfactory results.

DIAGNOSTIC FIRE MODELS

The Problem

Research on "controlled combustion" (fires in engines and furnaces) has made good progress at relatively low cost in time and resources through study of the properties of model combustion systems. Can models be designed to reflect the properties of large-scale uncontrolled combustion, as in bombed cities or forest fires? Such diagnostic tools would aid in exploring new techniques of controlling mass fires.

The Approach

With the support of the Office of Civil and Defense Mobilization, the Station will try to develop such fire models by a series of studies that will:

- ...investigate means of burning solid fuels under steady state conditions.
- ...diagnose test models burning solid fuels under a variety of conditions to supplement behavior data from full-scale fires and lead to a design of a satisfactory "predictive model."

Where We Stand

Design of laboratory test equipment for this one-year project was begun in 1958. Experimental work will be done in 1959.

EFFECTS OF MASS FIRES ON PERSONNEL IN SHELTERS

The Problem

In World War II some people died without apparent cause while peacefully resting in shelters as bombs dropped and fires burned overhead. Carbon monoxide poisoning, asphyxiation, or excessive heating of air in the shelter were possible causes of death. Since nuclear explosions can produce large area fires, it is essential to study the effects of such fires on people taking shelter within the fire zone. Also, fire-fighting agencies are concerned about hazards to nearby populations and to crews who must work close to the fire front.

The Approach

With funds granted by the Office of Civil and Defense Mobilization (formerly FCDA), the Station will conduct field tests on controlled burns with three broad objectives:

...to determine if heavy concentrations of carbon monoxide or other toxic gasses are present and learn if oxygen is deficient in shelters or areas surrounded by fire.

...to determine the temperatures to be expected within a shelter in a fire area.

...to determine the size of cleared area needed to protect personnel surrounded by fire.

Where We Stand

This one-year project was started in late 1958. Field tests will be conducted in 1959.

RADIANT ENERGY FROM BURNING FOREST FUELS

The Problem

The amount of heat energy radiated from common fuel materials in the forest is pretty much an unknown quantity. This is one of the more important kinds of information needed to predict more accurately the behavior of forest fires. Such information would also enable us to calculate the intensity of a fire from measurements of the residual fuels within a burned area.

The Approach

The Forest Service has granted cooperative student-aid funds to a graduate in the University of California Engineering Department at Los Angeles to start this work. The study will:

...determine the proportion of total energy released as radiation and convection.

...determine the residual heat value of the partially burned material remaining after combustion.

...determine combustion efficiency.

Where We Stand

This two-year project was started in late 1958. First phases of the study involve the development of test equipment for measuring heat values in unburned and partially burned forest fuels.

PROJECT CIVIL

The Problem

The detonation of a high-yield nuclear weapon at or near the surface of the earth produces a serious radiological hazard over a great area. Theoretical analyses of convection columns above large-scale fires indicate that updraft velocities can exceed the terminal downward velocities of most radiological fallout particles. It would appear, then, that convection columns induced by fires set by the detonation, or deliberately set after the detonation, could have a marked effect on fallout patterns. Also, an analysis of this effect could give some insight into the air flow in the vicinity of such convection columns.

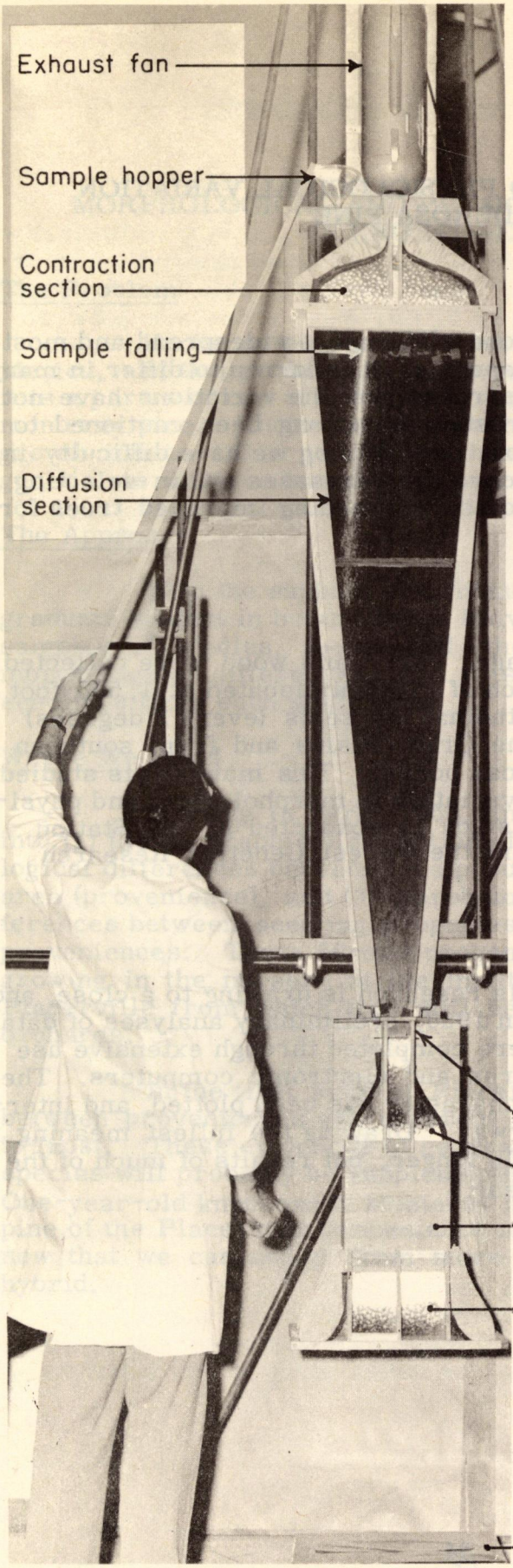
The Approach

The Station's work, conducted in cooperation with the University of California Engineering Department as part of the national civil defense program, is limited to an analytical and experimental study on a laboratory scale. It involves selection of a fallout simulant and development of methods for spreading the simulant and measuring its distribution pattern. The experimental determination of the effect of fires on fallout distribution is limited to investigations which can be conducted in a 6-foot by 6-foot low-velocity wind tunnel.

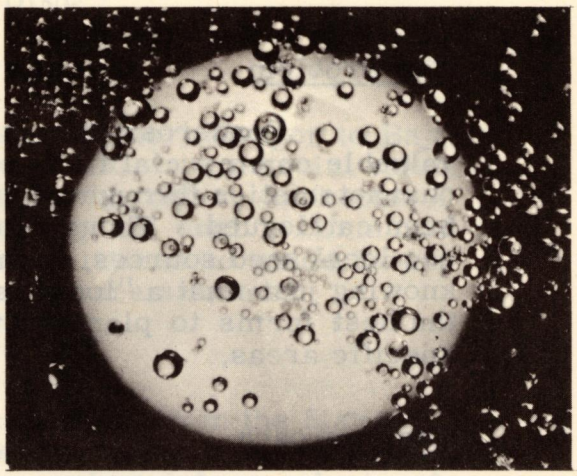
Where We Stand

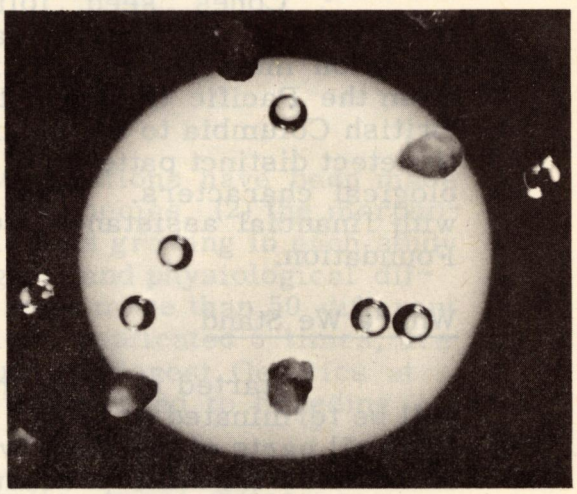
This project, started in June, 1957 was closed out in 1958. Simulated fallout has been sieved into 7 particle-size fractions, and a flock gun and associated equipment adopted for use as a fallout disperser. Experiments were run in the wind tunnel at the San Dimas Experimental Forest with gas burners to simulate mass fire conditions. These tests indicated that fire-induced convection columns exert a marked effect on fallout patterns. A convection column probe to measure velocities has been designed.

A device has been designed for the separation of irregularly shaped particles on the basis of their fall velocities. Small glass spheres of various sizes (the type used in the manufacture of reflectorized road signs) are mixed with the fallout and the mixture is run through a vertical wind tunnel. As the velocity through the wind tunnel is decreased, successive fractions are separated.



Vertical wind tunnel for particle-size separations. Below, photomicrographs of mixture of glass spheres and separated fraction of constant fall velocity.





MORPHOLOGICAL AND PHYSIOLOGICAL VARIATION IN PONDEROSA PINE

The Problem

Ponderosa pine is one of the most widespread and most valuable commercial timber species. It is known to differ in many characteristics throughout its range, but the variations have not been catalogued. Though foresters have long been cautioned to use local seed sources, without this catalog we have difficulty in knowing just what a "local" source encompasses and in selecting the best forms to plant or to use in breeding improved trees for specific areas.

The Approach

Cones, seed, foliage, bark, and wood were collected from each of 10 trees in each of 130 plots located at 1,500-foot elevation intervals along latitudinal transects (every 2 degrees) from the Pacific Ocean to the Great Plains and from southern British Columbia to the Mexican border. This material is studied to detect distinct patterns of variation in morphological and physiological characters. This study is conducted by the Station with financial assistance from the Forest Genetics Research Foundation.

Where We Stand

Started in 1955, this research is drawing to a close, and will be terminated in 1959. In 1958, preliminary analyses of data from all parts of the study were completed through extensive use of business machine procedures and electronic computers. The geographic variation in each character has been plotted, and interpretation of the facts is underway. Drawing the fullest meaning out of the data will take a while longer, but results of much of the study will be available next year.

MORPHOLOGICAL AND PHYSIOLOGICAL VARIATIONS IN KNOBCONE PINE

The Problem

Knobcone pine grows from southeastern Oregon to Baja, Mexico, and though this species is now of little commercial value, it is a parent of one of our most impressive hybrids: knobcone X monterey pine. Knobcone pine varies a great deal in form and growth habits. Can we isolate these variations to guide forest geneticists and tree breeders in selecting parent forms?

The Approach

With the support of a financial grant from the Station, a graduate student in botany at the University of California collected samples of needles, twigs, and other material for analysis of morphological differences, and is studying differences between seedlings from each study area.

Where We Stand

Starting in early 1958, investigations have been made into (1) the geographic distribution of the species, (2) the morphological differences between tree populations growing in each study area (provenience), and (3) morphological and physiological differences between seedling progenies from more than 50 different proveniences. These 50-odd progenies, replicated 5 times, are growing in the nursery at the Institute of Forest Genetics at Placerville from which they will be transferred to breeding orchards.

In the first year at Placerville, great differences between proveniences are apparent in growth rate and reaction to frost. These evidences of geographic (racial) variation in this species will probably be supplemented by difference in form. One-year-old knobcone X Monterey hybrids bred from knobcone pine of the Placerville provenience suffered frost injury. We know now that we can select from more hardy parents to produce the hybrid.

PHYSIOLOGY OF PINE FLOWERING

The Problem

Relatively little is known about the biology of flowering and reproduction in pines. Knowledge of these phenomena is of more than academic interest. Basic studies in this field can provide fundamental information as to why many pines are slow or irregular in seed production. This information can be applied in genetic research and in developing methods to induce early, abundant, and regular flowering and seed production.

The Approach

Under a financial grant from Resources for the Future, Inc., through the University of California, the Station is conducting basic laboratory studies of flowering processes. Much of this is a biochemical investigation of reproductive and vegetative pine tissues; it leans heavily on the use of radioactive tracers to follow the pathway by which different substances are metabolized as plant cells develop. One phase of the project, a study of the effect of boron on carbohydrate metabolism in pine pollen, is supported by a grant from the National Science Foundation. The California Institute of Technology is also cooperating and has appointed the project biochemist a research fellow at the Institute.

Where We Stand

Now in the third year of a 5-year grant, we find that many other research agencies have started to work on inducement of flowering, some through laboratory study of fundamental processes, others through empirical trials in the field. In view of this development and to avoid unnecessary duplication, we have decided to put more emphasis on studies that are not conducted elsewhere and concentrate on studies of pine pollen. In 1958 this work included biochemical study of carbon dioxide fixation and adaptive enzyme formation in pollen metabolism and work on glucose metabolism and oxygen concentration. Boron was found to stimulate growth of the pollen tube.

With the help of a University of California graduate student, we have found a substance (tri-phenyl tetrozolium chloride) that stains live pollen, but not dead pollen. This finding points to a method of testing pollen viability that will be far superior in speed and convenience to the germination tests now used. Its reliability for the purpose is now under study at the Institute of Forest Genetics.

ANATOMY OF PINE FLOWERING

The Problem

When do the flowers (conelets and catkins) begin to form in pines? What are the patterns of growth as the flowers develop? We know very little about these processes, yet such knowledge is basic to development of methods for improving seed production and tree breeding.

The Approach

With the aid of funds granted by the Station, a staff member of the University of California Botany Department at Davis, traced the development of plant cells that form flowers on the twigs of ponderosa pine.

Where We Stand

This short-term study has provided some valuable clues: At 3,000 feet elevation on the west slope of the Sierra Nevada, tissues that develop into pollen-bearing catkins appear in May; female flower primordia (the start of seed-bearing conelets) are formed in early fall—September and October. These nascent conelets do not go completely dormant in the winter, as was formerly believed, but continue to develop whenever the temperature is warm enough. These findings are of practical importance in tree breeding because they make it possible to decide by early fall whether breeding on ponderosa pine will be possible the next year.

CHEMICAL COMPOSITION OF PINE TURPENTINE

The Problem

Few groups of plants have been analyzed systematically, species by species, to determine the distribution of a group of chemical substances. This study sought such basic knowledge for the pines through chemical analysis of turpentine.

The Approach

Oleoresin samples were collected from pines in the Eddy Arboretum at the Institute of Forest Genetics and in their native habitat. In the laboratory these samples were subjected to fractional distillation, and the physical properties and composition of the terpenes in each fraction were identified. Started almost 20 years ago, the work was greatly speeded during its last 4 years by financial grants from the Rockefeller Foundation through the University of California.

Where We Stand

Turpentines of 94 different pines have been analyzed, and the last in a series of 30 analytical reports has been published. Besides discovering several new chemical substances in pine turpentine, this investigation has contributed to a better understanding of the genetic relationships among pines. It has helped formulate hypotheses explaining the resistance of pine species and hybrids to certain insects, and this in turn emphasizes the importance of determining the chemical composition of pine hybrids. It has provided diagnostic criteria for identifying species and hybrids. And it has thrown new light on the distribution and evolution of pines.

In 1958 this project was completed with the preparation of a comprehensive manuscript summarizing the findings.

ECONOMICS OF CHRISTMAS TREE HYBRIDIZATION

The Problem

One of the hybrids produced at the Institute of Forest Genetics—the cross between lodgepole pine and shore pine—shows promise for use as a Christmas tree. Can it be mass produced economically in marketable form?

The Approach

With funds granted by the Critchfield Brothers, Station geneticists are guiding experimental tree-breeding operations by the company.

Where We Stand

Started in May 1957, this project has completed routine breeding operations (cone-bagging, harvesting of cones, and extraction and handling of seeds). Final results are yet to be determined through nursery and field tests.

Artificial pollination of pine conelets.

OLD-GROWTH REDWOOD MANAGEMENT

The Problem

A 20- to 30-year supply of old-growth redwood timber still remains in northwestern California. To foresters and timber owners, redwood timber is a special challenge. It has several unusual characteristics such as great size, special qualities of the wood, and high growth potential. It presents many difficult problems of logging and utilization—for example, large amounts of defective material and tremendous quantities of highly flammable, decay-resistant logging slash.

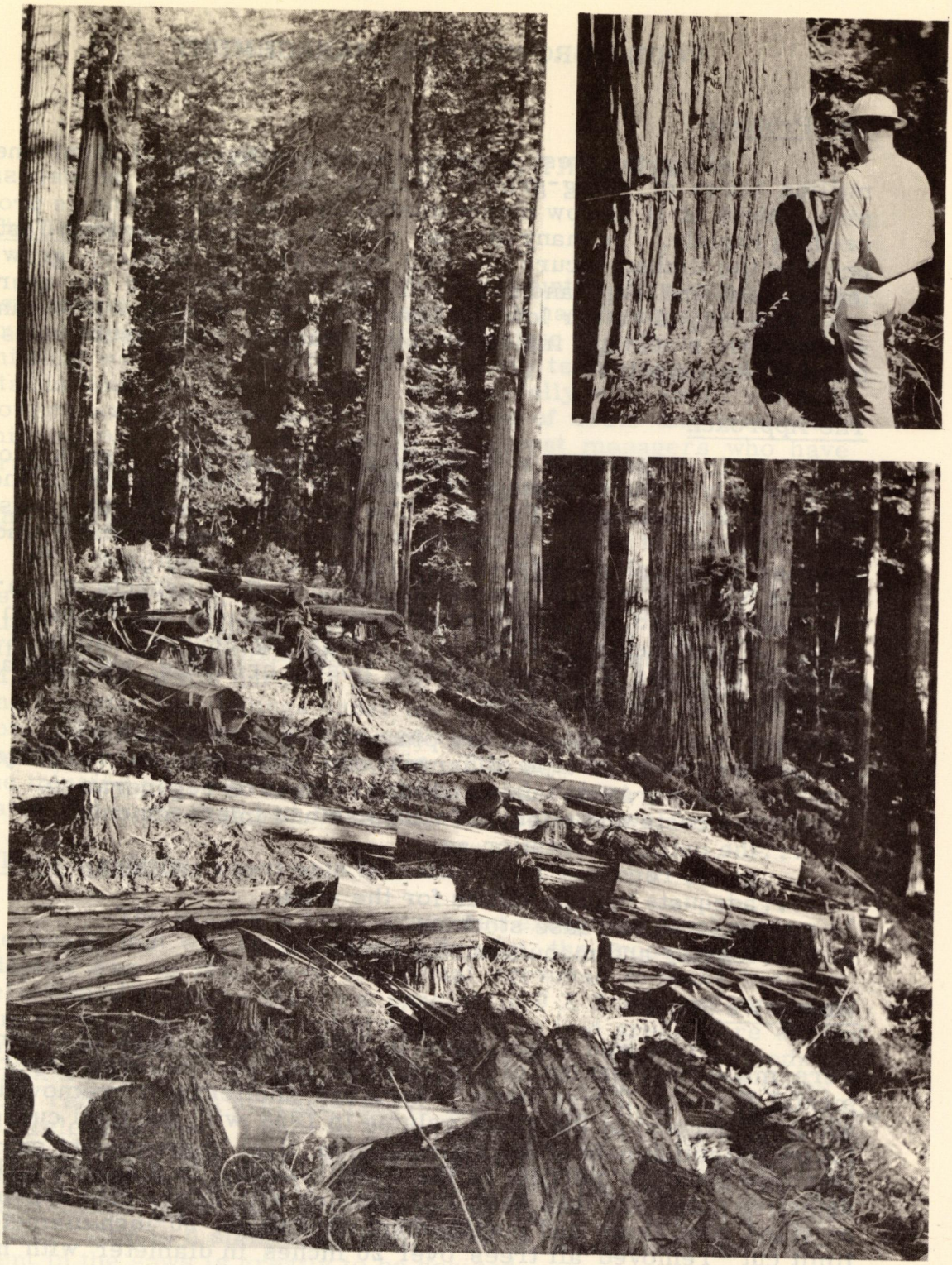
The Approach

Under a cooperative agreement with the Simpson Redwood Company, the Yurok Redwood Experimental Forest and adjoining lands of the Company in High Prairie Creek, Del Norte County are being used as a field laboratory for experimentation in silvicultural management. The Company is building and maintaining roads, logging the timber, and providing technical assistance and financial contributions. The Station is conducting the technical aspects of the research program, and the staff of the Six Rivers National Forest is aiding in timber sale administration on the federal part of the research area, where publicly owned stumpage is sold to the Company at the appraised valuation.

Replicated methods of cutting will test even-aged and uneven-aged management, and the study will evaluate natural regeneration and subsequent growth, logging costs for different intensities of cutting and methods of logging, and growth of residual stands. It will also investigate ways to maintain soil productivity, minimize erosion and undesirable streamflow changes, get maximum utilization of sawtimber and wood residue, and abate the logging slash fire hazard.

Where We Stand

The cooperative agreement became effective in August 1956 and will run 7 years. The first year was spent in making plans, laying out study areas, surveying roads, and appraising approximately 18 million board-feet of timber to be logged in the first series of cuttings. Road construction is now well underway and a bridge across High Prairie Creek—a key point in the transportation system—has been constructed. Choppers began felling on the first clear-cut units in September 1958. Detailed study of comparative logging costs has begun.



First-stage felling of redwood on an experimental unit to be clear cut. Only redwood trees under 6 feet in diameter were cut in this first stage.

A technician measures a residual tree on a selection cutting area at Yurok Redwood Experimental Forest.

YOUNG-GROWTH PINE MANAGEMENT

The Problem

Along the west slope of the Sierra Nevada is about one million acres of young-growth timber, predominantly ponderosa pine. Much of it is now merchantable in size and logging is proceeding rapidly. In many stands, growth is extraordinarily fast because the timber occurs in a belt where rainfall is heavy, growing seasons are long, and soils are relatively deep. On the average, stocking is rather low and timber quality is poor. How can we improve stocking, improve timber quality, and assure satisfactory regeneration?

The Approach

In cooperation with the Soper-Wheeler Company, a program of silvicultural management studies has been started on the Challenge Experimental Forest. The company constructs roads, logs, disposes of slash, prepares seedbeds for regeneration, and supplies technical assistance and financial contributions. The Plumas National Forest assists on administrative aspects of timber disposal, and the Experiment Station conducts the research work. Experimental cuttings are comparing several cutting methods in terms of growth, yields, costs, breakage, and logging damage to the residual stand.

The experiments are planned to get information on:

- ...the effects of type of harvest cut, slash disposal, seedbed preparation, and hardwood control on regeneration.
- ...the costs and effects of timber stand improvement.
- ...the optimum rotation age.
- ...grade recovery from different size trees and logs.
- ...adequate volume tables for the area.
- ...ways to increase stocking.
- ...logging and manufacturing costs.

Where We Stand

Work was first begun in 1958. Three types of cutting were made on a series of 4-acre plots on the Challenge Experimental Forest. These were: two-stage shelterwood—removed about 70 percent of the stand volume in 1958 with the final cut to follow establishment of the reproduction; light improvement cut—removed about 20 percent of the volume mainly in diseased and defective trees and less desirable species with future cuts dependent on stand conditions and management objectives; 20-inch diameter limit cut—removed all trees over 20 inches in diameter with no efforts made to protect small residual trees. Three slash disposal and site preparation treatments were tested in each 4-acre plot. One-third of the plot received only top-lopping, one-third received slash disposal and site preparation in October, and on the final third, slash disposal and site preparation will be delayed until the next good seed year.

THINNING PINE SAPLING THICKETS

The Problem

Many places on the Blacks Mountain Experimental Forest contain groups of pine saplings which have stagnated owing to excessively dense stocking. To stimulate growth, a program of thinning was begun in 1955. Preliminary tests suggested that the stands could be thinned more economically with small portable power saws than with axes. Knowledge of costs and methods of thinning with power saws would aid forest managers who have areas with similar sapling thickets.

The Approach

As an adjunct to the thinning program, an advanced forestry student from the University of California was employed to supervise the thinning, and collect observations and records on efficient crew organization, procedures, and costs of the work. Afterwards, while enrolled at the University, this student analyzed and reported the findings under the guidance of a forestry professor. The Experiment Station contributed a small sum to assist in paying for the cost of the analysis. The objectives were to describe the thinning procedures and problems and report the production rates and costs that had been collected during two field seasons.

Where We Stand

The work has been completed except for final review of the report that will be published. Briefly, the procedure that was adopted was to train each individual crewman to make his own selection of trees to thin to a spacing of 9 X 9 feet and to assign him working strips between string lines so that areas were worked out systematically without skips or overlaps. During periods in which a total of 1,114 man-hours were expended, 22,821 trees were released—an average rate of slightly less than 3 man-minutes per released tree. Labor at $1.75 per hour cost about 9 cents per released tree, and power saw operation, repair, and depreciation about 1 cent—a total of 10 cents. Lost time for saw repairs and maintenance consumed practically one-fourth of the total man-hours. This is a significant item showing that further improvement in the saws is greatly to be desired.

FOREST TREE PHYSIOLOGY

The Problem

With increasing frequency, forest regeneration studies reach points where the investigators realize that they do not understand the basic physiological processes and requirements of trees as living organisms. We need to gain greater insight into these processes and requirements if we are to regenerate and grow timber crops more effectively.

The Approach

To gain this knowledge, the Station is working jointly with the staff of the California Institute of Technology on a broad study of the physiology of conifer seedlings. Experiments underway include:

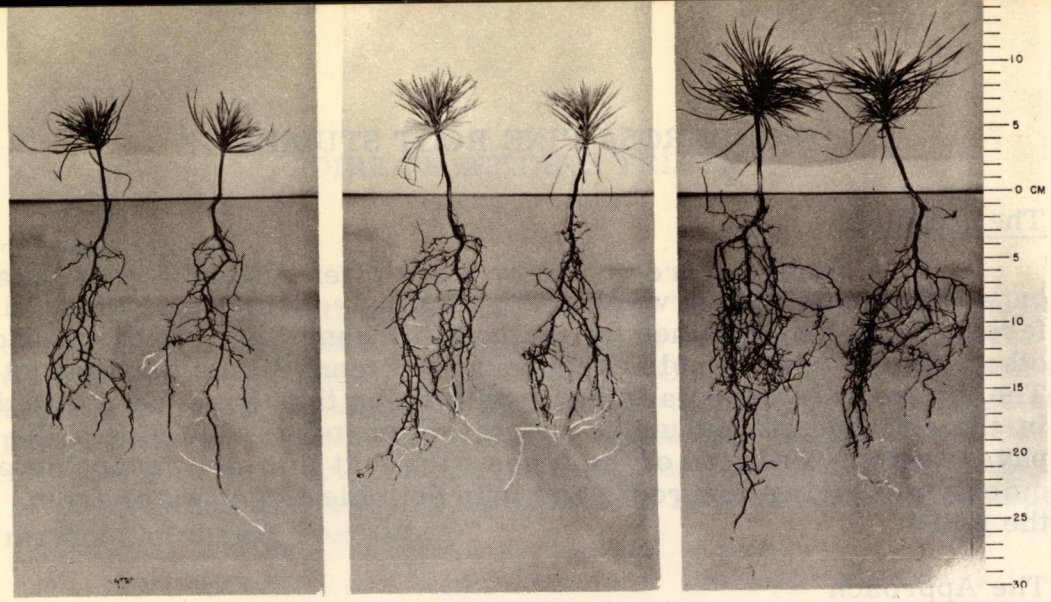
- . . . effects of temperature and photoperiod on seed germination, seedling growth and dormancy, and flower production.
- . . . development of cultural techniques to stimulate Douglas-fir roots.
- . . . effects of Gibberellic acid on seedling growth.
- . . . effects of storage on pine seedlings.

Where We Stand

As basic research goes, this project is just well started. The first work was begun in 1956, and experimental results are beginning to emerge. In the largest experiment so far—a study of the effect of temperature on seedling growth—we have found that both redwood and Jeffrey pine seedlings make greater top and root growth when daytime temperatures are increased than when nighttime temperatures are boosted. Douglas-fir responds about the same to heat stimulus in either light or dark periods. Another experiment showed that photoperiod influences bud dormancy in Coulter pine and bigcone Douglas-fir.

In an attempt to produce catkins and cones on conifers at an early age, we are subjecting young trees to a series of alternate 2- to 3-month summer and winter growing conditions. Three loblolly pine trees produced cones on the eighth node during the second calendar year.

Preliminary results in the study of storage of pine seedlings have indicated: First, starch decreases in the plant during storage. Second, activity of the enzyme dehydrogenase decreases in the middle of the storage period (mid-winter) and then increases again (spring). Third, the ratio between water content and dry weight of seedlings changes little during storage, and this ratio does not seem to be related to the seedlings' ability to grow when outplanted.



Day and night temperatures affect the growth of Jeffrey pine seedlings. B received extra heat at night; C extra heat in the daytime. Although both received the same amount of extra heat, C benefited more.

MATURATION AND STORAGE OF SEEDS

The Problem

Tree seeds usually are much more difficult to handle and store than the seeds of farm crop plants because they have not been improved and modified to our purposes by long periods of cultivation. Many of them are highly specialized organs that give a great deal of difficulty in collection and storage. They are also expensive and difficult to obtain in the large quantities needed for the expanding reforestation programs. The problem is to learn more about their physiological requirements in order to obtain the highest germination.

The Approach

The Station is making financial grants to the University of California to investigate (1) biochemical changes and growth stimulators during the physiological maturing of sugar pine and Jeffrey pine seeds, and (2) biochemical changes that occur in immature and mature seeds during storage. The research will be conducted by a graduate student. The University and Station will jointly supply laboratory facilities, technical guidance, and money for salary, travel, and supplies.

Where We Stand

Cone collections were made during the summer of 1958 to include different stages of seed development. Preliminary weights and measurements were taken and the cones were placed in cold storage. Biochemical studies will be started during the winter of 1958-59.

PONDEROSA PINE ROOT STUDIES

The Problem

Coniferous tree nursery stock often differs a great deal between lots in the survival after planting. Sometimes these differences can be explained by methods of handling, weather, and other readily accountable conditions, but many times they cannot. The difficulty is especially acute with trees that have been lifted in the fall and stored under refrigeration over winter. Is the physiological condition of the trees such that they are incapable of quickly producing new roots and thus not able to get water from the soil?

The Approach

The University of California supplies special greenhouse facilities and related laboratory equipment, and the Forest Service and California Division of Forestry assist in the production of trees for the investigation. The Station and the University jointly plan and conduct the experiments. The specific problems being studied are:

...the initiation of new root growth upon ponderosa pine nursery stock lifted, stored, and transplanted at various times and subjected to different temperatures.

...the physiological changes in nursery stock during winter storage.

...the best time to lift trees in the fall for overwinter storage.

...the best time to lift trees in the spring for field planting.

Where We Stand

The project was started in 1955. Studies of root activity one month after replanting in special containers with controlled soil temperatures in a greenhouse at the University in Berkeley have yielded the following preliminary findings:

1. Regeneration of a new root system by transplanted ponderosa pine seedlings was dependent upon elongation of short laterals and the initiation and elongation of new laterals.
2. Root elongation occurred in the greenhouse in every month except July and August, the greatest activity being in the spring.
3. Root initiation occurred only during December to June, and the greatest activity came in the spring just before terminal buds burst.
4. Seed source and nursery location both affected the physiological condition of the seedling and its subsequent response when transplanted.
5. The physiological behavior suggests that spring planting has more in its favor than fall planting.
6. That stock lifted at the Mt. Shasta Nursery after November 1, could be stored longer without harmful effects than stock lifted in September or October.

DIRECT SEEDING TRIALS

The Problem

In the southern Sierra Nevada, as in many other parts of California, methods for reforestation of brushy old cutover timberland are not wholly satisfactory. One remedy that appears to have merit is to plant tree seed rather than nursery propagated plants because of probable reduction in cost, possibly better development of the root systems of the trees, and more flexibility in programing the work. The problem is to develop dependable methods of direct seeding.

The Approach

The study is being conducted on the land of Yosemite Mountain Ranch, Ltd. This organization prepares the planting sites and assists in planting the seeds according to technical instructions supplied by the Station. The Experiment Station plans the work and measures the results. The areas to be planted are thoroughly cleared of vegetation with bulldozers. Tests include a variety of methods for preventing rodent depredations to the seeds with screens and repellents, application of fungicides and insecticides, and comparison of the suitability of several species of trees.

Where We Stand

Work has been underway since 1953. So far the studies have demonstrated that:

1. Tetramine-acetone treatment did not reduce the viability of fresh pine seed but did seriously affect the viability of old seed.
2. Tetramine-acetone treatment provided excellent rodent protection.
3. Surface coating seeds with tetramine or endrin offered no protection against rodents.
4. Endrin treatment was effective against mice but not for larger rodents.
5. Cutworm and wireworm damage to new seedlings is least during the first spring after complete brush removal and becomes more serious as grass and weeds reinvade the area. The damage may cause 100 percent mortality of seedlings by the second or third year.
6. Dieldrin effectively reduced losses due to cutworms and wireworms.
7. Sugar pine seedlings were more susceptible to frost injury than either ponderosa or Jeffrey pine.

BIOLOGY AND CONTROL OF SEED-EATING FOREST ANIMALS

The Problem

Foresters have found time and again that attempts to artificially or naturally reseed pines and Douglas-fir fail unless rodents are eliminated or in other ways prevented from eating the tree seeds. Poisoning has had some success and some disappointing failures. Wire screens over seed spots and other similar mechanical barriers are effective only in certain circumstances and they are expensive.

The Approach

The Zoology Department of the University of California at Davis is conducting a variety of studies with assistance from the Station. The University provides the scientists and the Station facilitates the work by providing quarters, field study areas, and small financial grants to assist with travel expenses.

Studies include determination of the species involved, investigations of the life histories of rodents and other seed eaters, their populations and food habits, and use of repellent substances.

Where We Stand

From 1952 to 1957 the work was concentrated largely in the Douglas-fir forest type on the Six Rivers and Shasta-Trinity National Forests with a lesser amount of effort directed to ponderosa pine in other areas. In 1958, the project was moved to the Susanville Research Center in the ponderosa pine-Jeffrey pine type. Over the years, a large amount of information has been collected and numerous publications have been issued concerning species, food habits, animal habits and population levels, but the ultimate objective of learning how to reduce seed losses to a tolerable level remains to be solved.

GAME BROWSE RESTORATION

The Problem

A majority of the big-game ranges that are critical for winter survival of deer in California are badly run down. They are producing much below their forage potentials, and consequently they cannot maintain the present high populations of deer, let alone the even higher populations foreseeable for the future. We need to develop practical methods for improving these ranges by seeding browse plants.

The Approach

To discover such methods, the Station is conducting a series of studies in cooperation with the California Department of Fish and Game. We are collecting fundamental information on the ecology of native browse species, selecting and propagating elite strains of desirable plants, and testing methods for breaking seed dormancy, evaluating planting sites, site preparation, time and depth of planting, and rodent control. The research is conducted with financial aid granted from federal Pittman-Robertson and state funds (in about a 3 to 1 ratio).

Where We Stand

So far research has centered principally on bitterbrush, a key native browse plant. Field study of its ecology has been completed and successful seeding methods developed for the critical northeastern region. Some attention has been shifted to other promising native and introduced species, to more economical methods of site preparation and seeding, and to additional areas, especially in southern regions.

In 1958, dormancy of wedgeleaf ceanothus seed was successfully broken. This critical first step opens up the possibility of using this palatable native browse in restoring depleted deer ranges. Aerial seeding of this light-seeded species holds some promise on new burns where ashes and loose soil provide needed cover.

Other studies showed that control of insect and disease pests may play an important role in maintaining bitterbrush ranges. Damaging pests include nine different groups of insects and two or more fungus diseases. Particularly important are the Great Basin tent caterpillar, budworms, and stinkbugs. We also made a good start on establishment of a browse seed orchard of particularly desirable strains of bitterbrush. Several selections were successfully propagated from cuttings.

BRUSHLAND WATERSHED MANAGEMENT

The Problem

Probably nowhere in California is the need for high quality water and effective slope stabilization greater than in southern California. In spite of all the water imported, 60 to 70 percent of the water used in the South Coastal Basin comes from local watersheds. This local water is not only the least expensive, it is usually the highest in quality. How can these watersheds—some of the steepest, most unstable, yet some of the most valuable watersheds in the country—be managed to meet the demands of a tremendous metropolitan area?

The Approach

Brushland watershed research in southern California is conducted on the San Dimas Experimental Forest in cooperation with the State Division of Forestry, which has provided about a third of the budget since 1946. The work includes fundamental studies through which we are learning what happens to rainfall and how water and soil movement are influenced by vegetation, geology, soils, topography, and land use. It also includes applied studies in which we are developing methods of watershed management that will provide maximum yields of clear, usable water without increasing flood and erosion hazards. The research program is of most direct benefit to watershed managers in southern California's chaparral-covered mountains, but much of the knowledge developed in this program can be adapted for brushland in other regions.

Where We Stand

Started by the Station in 1933, this work has discovered many of the fundamentals of how a watershed works. It has shown how to measure rainfall accurately in the mountains, that chaparral plants differ in rates of water use, and that surface runoff and soil moisture are influenced by soil depths and different kinds of cover. We have been able to estimate rainfall moisture losses, streamflow, and groundwater yields on entire watersheds, and the recent development of the nuclear soil moisture probe is sharpening water-yield evaluations.

Now, we are learning how much the yield of quality water can be increased by research-guided management. In Big Dalton watershed, crews from the Angeles National Forest and the Los Angeles County Fire Department are removing alders, oaks, sycamore, maple, willow and related stream bottom "water hogs" from 70 acres. In nearby Bell Canyon, 40 acres of chaparral located on deep soils were sprayed by a helicopter with brush-killer chemicals. The next job is to test these treatments on other California brushland watersheds of different geology and land use. Meantime, a fundamental field study has been started to measure the amount of rainfall intercepted by grass and returned to the atmosphere by direct evaporation. A related study is adapting a device for temporarily encasing all or part of a plant and obtaining a direct measurement of evapo-transpiration loss.

Southern California water yield study: Monroe Canyon before and after removal of water-wasting riparian vegetation.

SNOW MANAGEMENT RESEARCH

The Problem

California's most abundant, most valuable reservoir is its high mountain snow pack—a white blanket that annually covers about 12 million acres in the upper elevations of the Sierra Nevada and Cascade Mountains. Not only does the snow zone provide more than half the State's water, it is the principal source of streamflow long after the rains have stopped. The demands on this supply are increasing—farmers want more water to meet their irrigation needs; power companies want a uniform supply; flood engineers want water under control. Tomorrow the needs of each will be greater.

The Approach

Snow management research is being conducted by the Station in cooperation with the California Department of Water Resources, which is matching federal snow research funds. Our aims are to develop ways to manage timber and brushland watersheds in the snow country so as to increase streamflow, improve the timing of streamflow maintain water quality, and minimize floods and sedimentation.

At the Central Sierra Snow Laboratory near Donner Summit, we are conducting basic studies dealing with snow accumulation and melt. Nearby, five high country fir and pine watersheds are being calibrated for applied management studies. Another set of pilot watersheds in the headwaters of the Kings River is also under calibration. In the headwaters of the Truckee, with the University of California Department of Zoology, we are studying the effects of brushland conversion to pine forest on snow accumulation, water yield, and sedimentation. Similar measurements are underway in three other locations where logging is or has recently taken place. And at our Berkeley office we are doing our inventories and analyses.

Where We Stand

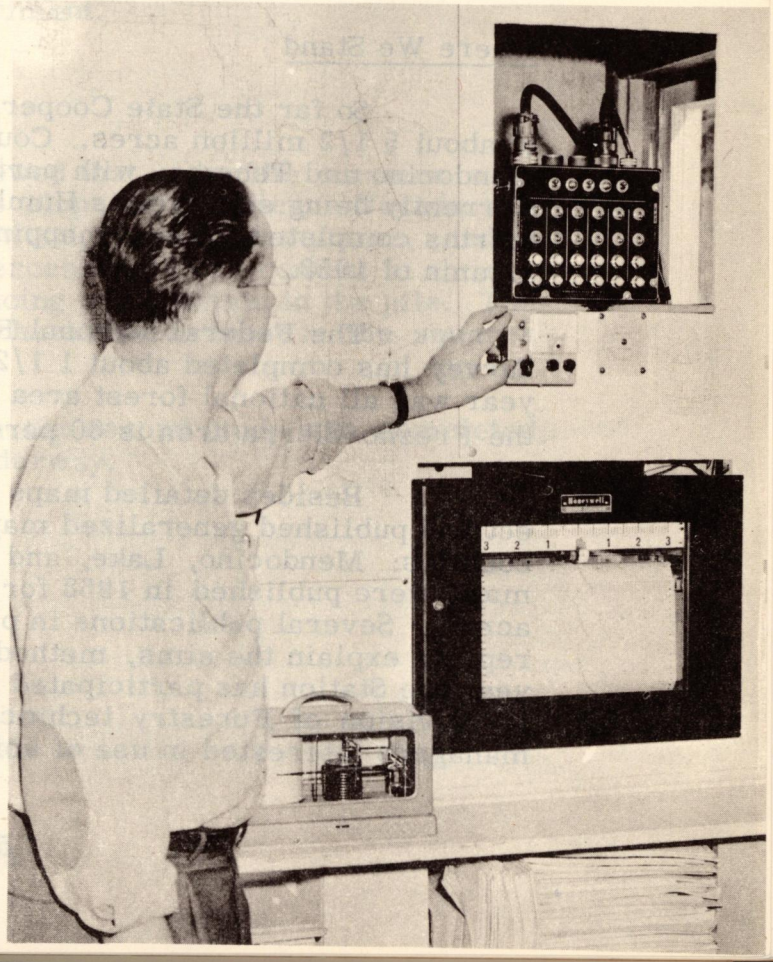
Starting the third year of cooperative snow management research, the project has completed one study and has 17 others in progress. Interesting and worthwhile results are beginning to come in.

An inventory of the snow zone shows that the Sierra has more brush cover than tree crown cover, and half the zone is bare rock, bare soil, or grass-covered.

The forests have, from a water loss standpoint, their plus and minus values. In 1958 summer soil-moisture losses were greater from forested slopes than open slopes. Last March and April, tree crown intercepted and evaporated about 9 percent of the precipitation. Winter evaporation from the snow pack in a large opening was more than 2 inches but only 0.2 inches from a small opening; under a forest canopy condensation exceeded evaporation, and the snow pack gained 2 inches of water.

In a conventionally logged area, more snow accumulated in the cut area, but spring melt was more rapid there. Related measurements in 60 forest sites of various sized openings and on different aspects, indicate that by strip cutting to take full advantage of shade and by trapping cold air, more snow can be accumulated and its melt delayed.

Technician demonstrating a radio-active probe and portable scaler which was used last summer to measure soil moisture losses at 60 forest sites.



Technician checking the automatic recorder of forest microclimate and heat budget at Central Sierra Snow Laboratory.

SOIL-VEGETATION SURVEY

The Problem

As management of wildland becomes more intensive, we have critical need to know the kind and distribution of soils and vegetation, their characteristics, and their relationships. Surveys can gather such basic information to guide land management for production of timber, forage, and water.

The Approach

A soil-vegetation survey on privately owned and state land is financed through appropriations to the California Division of Forestry, Department of Natural Resources. By a three-way agreement dated November 15, 1953, the Division of Forestry is responsible for general administrative supervision and for selection of survey areas. The Station provides technical coordination of the survey operation. The University of California analyzes soil samples and makes greenhouse fertility tests. Survey crews classify and map soils and vegetation as to soil series and phases, species composition and density of vegetation, and related landscape features, and they compile supplemental information on soil characteristics, plant species, and suitability of the soils for timber and range use.

The University is also cooperating with the Forest Service in a similar survey of national forest land in California.

Where We Stand

So far the State Cooperative Project has surveyed a total of about 5 1/2 million acres. Counties completed are Glenn, Lake, Mendocino and Tehama, with parts of Sonoma and Trinity Counties. Currently being surveyed is Humboldt County which is about three-fourths completed. Also, mapping began in the Shasta area in the autumn of 1958.

The Federal National Forest Cooperative Soil-Vegetation Survey has completed about 1 1/2 million acres. Completed this year was all national forest area in Tehama County. A survey in the Fresno-Sierra area is 80 percent completed.

Besides detailed maps of soils and vegetation, the project has published generalized maps of upland soils for three counties: Mendocino, Lake, and Glenn. New detailed soil-vegetation maps were published in 1958 for about three-fourths of a million acres. Several publications in professional journals and Station reports explain the aims, methods, and uses of this survey. Each year the Station has participated in training sessions and field tours for Division of Forestry technicians, farm advisors, and land managers interested in use of soil-vegetation information.

AIR DRYING OF INCENSE-CEDAR

The Problem

Thick incense-cedar planks are used in manufacturing pencil slats. The severe drying conditions encountered during California's hot dry summer months create seasoning problems, particularly surface checks, that result in a considerable loss of material. This work was undertaken in an effort to improve air-drying practices and reduce such losses.

The Approach

Two field studies were set up in an air-drying yard. First, during the dry season, several pile spacings were tried, and drying the material in the form of squares was compared to drying of random width planks. Then, at the beginning of the winter wet season, another test was made to determine the effect of form of material (squares versus wide planks) on drying time. The California Cedar Products Company supplied test material and aided in conduct of the experiment.

Where We Stand

The earlier study showed that under the summer conditions encountered on the west slope of the Sierra Nevada all the segregations studied—heartwood, sapwood, squares, and planks—dried to less than 15 percent moisture content in about 15 weeks, regardless of pile spacing and position in the pile. The number and severity of surface checks were least in the squares and most in the wide plank.

In 1958, field work on the second study was completed, and analysis of the results is underway.

PUBLICATIONS

Anonymous.
Burning index computing tables. Calif. Forest and Range Expt. Sta. (n. p.)

Tables used to compute the burning index from fire weather observations.

Anonymous.
California fire danger rating. Calif. Forest and Range Expt. Sta. 28 pp., illus.

Provides instructions and procedures for making fire weather observations, computing, and using the burning index in the California fire danger rating system.

Anonymous.
California fire danger rating—fire weather station installation and maintenance. Calif. Forest and Range Expt. Sta. 51 pp., illus.

Describes procedures for selecting fire weather station sites, and for installing and maintaining fire weather equipment.

Anonymous.
Tioga's ghosts. Calif. Forest and Range Expt. Sta. Misc. Paper 28, 4 pp.

A popularized account of the lodgepole needle miner in Yosemite National Park, and studies in progress to control it.

Anonymous.
What's wrong with my trees? Calif. Forest and Range Expt. Sta. Misc. Paper 26, 2 pp., illus.

Describes symptoms and extent of spread of foliage diseases of hardwoods, chiefly the leaf blights of California laurel and the leaf spot fungus of black oak; 1958 rains caused epidemic build-up of these endemic diseases.

Anderson, H. W.
Progress in snow management research in California. Western Snow Conf. Proc. 1958: 12-21.

Plans, methods, and some results from 18 studies now underway in California are summarized.

Anderson, Henry W.
Progress report 1957-58, cooperative snow management research. Calif. Forest and Range Expt. Sta. 56 pp., illus.

Objectives, methods, plans, and results of snow management studies in the headwaters of five major California river basins are summarized and indexed. Basic meteorological, snow, sediment, and streamflow data are included.

Anderson, Henry W.
Rain-snow flood sources meteorologically defined. Bul. Amer. Meteorological Soc. 39 (3): 174-5 (Abstract).

Flood peak discharges of 54 watersheds of the Willamette Basin, Oregon in 43 storms were related to five meteorological and four watershed variables. The results were interpreted in terms of the relative frequency of floods in various elevation zones of western Oregon.

Anderson, Henry W., and Hobba, Robt. L.
Forest effects on floods in Northwest. Amer. Geophys. Union Trans. 39 (3): 504 (Abstract).

Effects of forest conditions on floods for three areas of the Pacific Northwest were evaluated using multiple regression, covariance, and double-mass analysis.

Anderson, H. W., Rice, R. M., and West, A. J.
Forest shade related to snow accumulation. Western Snow Conf. Proc. 1958: 21-31.

Electronic computer was used to test several measures of forest conditions as they affect snow accumulation. The evidence was that forest variables were improved when specifically designed to index the separate effects of forests on solar radiation received at the snow surface, back radiation from the trees, and the interchange of energy between forests, clouds, and sky.

Andrews, L. A.
Added pen takes guess out of flow gage. Engineering News-Record. June 19, 1958, p. 125.

Describes an attachment for indicating pen reversals on FW-1 water-level records to aid in correct interpretation of streamflow records.

Andrews, L. A., and Broadfoot, W. M.
The San Dimas soil core sampler. Soil Science 85 (6): 297-301.

Describes soil sampler to take cores in deep soils with a minimum of disturbance to either the core or the area sampled.

Bentley, J. R., and Fenner, R. L.
Soil temperatures during burning related to postfire seedbeds on woodland range. Jour. Forestry 56 (10): 737-740, illus.

Depth of charring and incineration within the mineral soil proved better criteria than surface appearances for judging soil temperatures during burning and favorable conditions for postfire seeding.

Bentley, J. R., Green, L. R., and Wagnon, K. A.
Herbage production and grazing capacity on annual-plant range pastures fertilized with sulfur. Jour. Range Mangt. 11: 133-140.

Herbage production was increased approximately 60 percent above unfertilized ranges over a 5-year period; grazing capacity was increased 50 percent.

Buttery, R. F., and Green, L. R.
Checklist of plants of the San Joaquin Experimental Range. Calif. Forest and Range Expt. Sta. Misc. Paper 23, 32 pp.

Abundance and habitat descriptions for each species growing on this central Sierra foothill laboratory.

Callaham, Robert Z.
Better trees through systematic breeding. 33rd Natl. Shade Tree Conf. Proc. 1957: 271-275.

Discusses the roles of genetic research and tree breeding in improving the characters of forest tree species for forestry purposes and gives the techniques and procedures used. Better shade trees will be an incidental result.

Callaham, R. Z., and Hasel, A. A.
Height growth of ponderosa pine progenies. Soc. Amer. Foresters Proc. 1957: 61-62.

Reports that (1) seed-size and germination are related to crop year; (2) seed-size, germination time, 2nd-year height-growth are related to elevation; (3) 2nd-year height-growth is related to seed-size, germination-time, and crop-year; and (4) 15-year height is related to 2nd-year height-growth, elevation, and elevation squared, but not to crop-year, seed-size, or germination-time.

Cornelius, D. R., and Graham, C. A.
Sagebrush control with 2, 4-D. Jour. Range Mangt. 11: 122-125.

Butyl ester of 2, 4-D at 2 pounds acid equivalent per acre gave best control of big, black, and silver sagebrush. Low volatile esters should be used if susceptible crops grow nearby.

Countryman, C. M., and Colson, De Ver.
Local wind patterns in Wildcat Canyon. Calif. Forest and Range Expt. Sta. Tech. Paper 27.

Shows some of the kinds of information that can be derived from fire-climate surveys.

Countryman, C. M., and Schroeder, M. J.
Prescribed burn fireclimate survey 1-57. Calif. Forest and Range Expt. Sta. Tech. Paper 29.

Describes the results of a fireclimate survey of a prescribed burn in the lower foothills of the central Sierra Nevada. Observations showed that there can be an increase in wind speed on the lee side of a fire under some conditions.

Court, Arnold.
Selection of "best" snow course points. Western Snow Conf. Proc. 1958: 1-12.

The median snow water equivalent of 5 points was found to be practically as good a measure of snow at snow course as is the mean of 17 points, both in estimating the "true" mean of the course and for predicting the flow of a nearby stream.

Gleason, C. H.
Watershed management—an annotated bibliography of erosion, streamflow, and water yield publications by the California Forest and Range Experiment Station. Calif. Forest and Range Expt. Sta. Tech. Paper 23. 79 pp., illus.

Describes 204 erosion, streamflow, and water yield publications. Author and subject indexes are given.

Graham, C. A.
Killing brush sprouts on open range land in California. Calif. Forest and Range Expt. Sta. Res. Note 136, 5 pp.

Chemical control following controlled burning was most effective and still economical if done for 3 years.

Green, L. R., and Graham, C. A.
Annual legumes on granitic soil in the central Sierra foothills. Calif. Forest and Range Expt. Sta. Tech. Paper 24. 11 pp.

Introduced species were successfully established only on bottomland soils; fertilization of native clovers offers the best choice for increasing legumes.

Green, L. R., Wagnon, K. A., and Bentley, J. R.
Diet and grazing habits of steers on foothill range fertilized with sulfur. Jour. Range Mangt. 11: 221-227, illus.

Beneficial changes in species composition and chemical content in turn influenced diet and grazing habits of steers.

Hall, R. C.
Environmental factors associated with oubreaks of the western pine beetle and the California five-spined engraver in California. Tenth Internatl. Cong. Ent. Proc. 4: 341-347.

Environmental studies indicate that beetle-caused mortality of ponderosa pine is associated with deficiencies in precipitation and soil moisture, and high temperatures during the growing season.

Hall, R. C.
Sanitation-salvage controls bark beetles in southern California recreation area. Jour. Forestry 56 (1): 9-11, illus.

Cutting high-risk trees in the Barton Flats Recreational Area of southern California resulted in a reduction in bark beetle-caused losses at a savings to the government. Sanitation-salvage in this area was as effective in checking beetle damage as it has been previously in northeastern California.

Hellmers, H., and Ashby, W. C.
Growth of native and exotic plants under controlled temperature and in the San Gabriel Mountains California. Ecology 39 (3): 416-428.

Describes a study to determine the species most adapted for survival and growth in the San Gabriel Mountains.

Hopkins, Walt.
More good water—research at San Dimas Experimental Forest applying fundamentals to entire watersheds. Calif. Forest and Range Expt. Sta. Misc. Paper 22. 6 pp., illus.

Highlights accomplishments at San Dimas Experimental Forest and present application of results to entire watersheds.

Hormay, A. L., and Evanko, A. B.
Rest-rotation grazing—a management system for bunchgrass ranges. Calif. Forest and Range Expt. Sta. Misc. Paper 27. 14 pp., illus.

Basic principles and practical steps for putting into operation a grazing system geared to improving and maintaining high forage and livestock production on California bunchgrass ranges.

Hubbard, R. L.
Hot water bath and thiourea break dormancy of wedgeleaf ceanothus seed. Calif. Forest and Range Expt. Sta. Res. Note 143. 4 pp.

Hot water followed by soaking in 3 percent thiourea for 13 hours gave 31 percent germination.

Hubbard, R. L., and Dunaway, David.
Variation in leader length of bitterbrush. Calif. Forest and Range Expt. Sta. Res. Note 145. 4 pp.

For five bushes studied, an unrestricted random sample of 19 to 39 leaders was required for a reliable estimate of average leader length.

Hubbard, R. L., and Pearson, B. O.
Germination of thiourea treated bitterbrush seed in the field. Calif. Forest and Range Expt. Sta. Res. Note 138. 6 pp.

Seed dormancy was successfully broken without damage to seedling emergence or survival.

Jensen, Arthur W., and Schroeder, Mark J.
A new measure of the build-up for fire danger rating in California. Calif. Forest and Range Expt. Sta. Res. Note 133. 5 pp., illus.

Describes the procedure used to determine the effect of the drying of heavy fuels on fire danger and to integrate this build-up factor into the California fire-danger rating system.

Keen, F. P.
Cone and seed insects of western forest trees. U. S. Dept. Agr. Tech. Bul. 1169, 168 pp., illus. July 1958.

A comprehensive, well illustrated work which covers cone and seed insect research between the years 1912 and 1917. Insects reared from major as well as minor western coniferous trees are included, with notes on their biologies, hosts, parasites and predators. Bibliography lists references through the year 1956.

Kimmey, J. W.
The heart rots of redwood. U. S. Dept. Agr. Forest Pest Leaflet 25. 7 pp., illus., July 1958.

Pictures and describes the two principal heart rots of redwood and lists the external indicators of their presence.

LeBarron, R. K.
What is unit area control? Jour. Forestry, 56 (9): 662-3.

Describes unit area control as a method of management based upon the recognition of condition classes within a forest. These condition classes are useful for planning silvicultural treatment, inventory, and forest regulation.

Lyon, R. L.
A useful secondary sex character in Dendroctonus bark beetles. Canad. Ent. XC(10): 582-4, illus.

Sexing D. brevicomis Lec. and D. monticolae Hopk. adults by examining the seventh abdominal tergite under 10X-15X magnification is shown to be both a rapid and accurate method. Observations on other species indicate that this character may be equally useful for sexing the entire genus.

Lyon, R. L.
California flatheaded borer. U. S. Dept. Agr. Forest Pest Leaflet 24, 7 pp., illus. June 1958.

An account of the distribution, hosts, life stages, and habits of the beetle. Evidence of attack and methods of controlling this important forest pest are discussed.

Maul, David C.
Silvical characteristics of white fir. Calif. Forest and Range Expt. Sta. Tech. Paper 25. 22 pp.

The distribution, life history, and growth of this important western tree.

May, R. H.
Development of the veneer and plywood industry in California. Forest Survey Release 34, 26 pp., illus.

Traces the development of California's veneer industry since 1868, and California's plywood industry since 1908. The boom in both began after World War II with expansion into Douglas-fir, hitherto undeveloped. California now produces about as much softwood plywood as it uses. Statistical tables and bibliography appended.

May, R. H.
One-fifth fewer sawmills active in California in 1957. Calif. Forest and Range Expt. Sta. Res. Note 139. 3 pp.

The business recession of 1957 reduced the number of sawmills active in California in that year as compared to 1956. Reduced activity was most noticeable in the smallest sizes of mills. The Redwood Region was hit a little harder than the Pine Region.

May, R. H.
Production of shingles and sawed shakes in California, 1956. Forest Survey Release 31. 7 pp., illus.

Almost 36,000 squares of shingles and shakes were sawed in 26 California mills in 1956, continuing a decline evident since about 1947. Redwood was the major species cut and Mendocino County led in volume of production.

May, R. H.
The production of poles, piling, and mine timbers in California, 1956. Forest Survey Release 32. 6 pp.

Pole production increased 250 percent in California from 1952 to 1956, far offsetting small decreases in piling and mine timber production over the same period. Douglas-fir was the major species used, followed by ponderosa pine.

May, R. H., and Baker, H. L.
Output of split products in California, 1956. Forest Survey Release 33. 9 pp., illus.

Output of split fence posts, grape-stakes, and similar products in California amounted to 21,433,000 board-feet of product, somewhat exceeding 1955 output. Redwood was by far the leading species used; Humboldt and Mendocino - the leading counties.

May, R. H., and Baker, H. L.
Output of timber products in California, 1956. Forest Survey Release 35. 35 pp., illus.

Summarizes results of a comprehensive survey of California timber products, showing a record 7.0 billion board-feet output in 1956. Gives details for major products, especially sawlogs which comprise 82 percent of total output and 91 percent of roundwood output. Production by species and county shown in appendix tables.

Miller, Harry R., Jr., and Phillips, Clinton B.
Preliminary tests of some new fire retardants. Calif. Forest and Range Expt. Sta., Res. Note 140. 4 pp.

Describes laboratory tests of a few potential new forest fire retardants, notes the study yet required on these materials, and lists the characteristics of an ideal fire retardant.

Miller, Harry R., Jr., and Reinecker, H. P.
Air tanker report—California, 1957. Fire Control Notes. 19 (2): 53-56, illus.

Describes the effectiveness of air tankers on forest fires in California in 1957 as well as some of the limitations noted by field personnel.

Mirov, N. T.
Composition of gum turpentines of pines XXX. A report on Pinus serotina, P. tenuifolia, and P. yunnanensis. Jour. Amer. Pharm. Assoc., Sci. Ed., 47: 410-413.

The chemical components of the turpentines of each species are given. The main components of each are: for P. serotina l-limonene 90 percent, for P. tenuifolia d-α-pinene 77 percent, and for P. yunnanensis l-α-pinene 87 percent. Summarizes findings presented in this and 29 previous papers.

Mirov, N. T.
Pinus oaxacana, a new species from Mexico. Madrono 14 (5): 145-50.

A pine formerly identified as Pinus pseudostrobus Lindl. is here published as a new species by the author. Its elevation to species rank is based on both morphological and biochemical features. Natural crosses with other species are cited.

Mirov, N. T.
The physiology of forest trees. Chap. 12. Distribution of components of turpentine among species of the Genus Pinus. The Ronald Press, New York, pp. 251-268.

This paper, presented at a symposium at Harvard University, gives information on the specificity of turpentines, the stability and variability of turpentine composition within a species, and the distribution of terpenes within the genus.

Mirov, N. T., and Blankensop, Mark.
A note on propagation of Torreya Californica. Jour. Calif. Hort. Soc. 19: 15.

Seeds of California nutmeg (Torreya Californica) germinate very slowly. Propagation of this rare conifer by cuttings is very easy.

Mirov, N. T., and Iloff, P. M., Jr.
Composition of gum turpentines of pines XXIX, a report on Pinus ponderosa from five localities: central Idaho, central Montana, southeastern Wyoming, northwestern Nebraska, and central eastern Colorado. Jour. Amer. Pharm. Assoc., Sci. Ed., 47 (6): 404-409.

Results of this and previous chemical analyses of turpentines show that regardless of provenience, and despite the existence of several varieties, this species always contains large amounts of $\triangle^3$-carene.

Murphy, James L.
Ground operations for helicopters. Fire Control Notes. 19 (2): 74-78, illus.

Describes helicopter ground crew organization and duties as well as how to locate, construct, and operate heliports and helispots safely and efficiently.

Murphy, James L.
Helitack crews pay off in California: Fire Control Notes. 19 (2): 94-96.

Describes use of specially trained Helitack crews in California in 1957 to suppress small remote forest fires in their early stages and to aid on large fires.

Murphy, James L.
Training the helitack crew. Fire Control Notes. 19 (2): 91-93, illus.

Outlines a suggested plan to train a crew to use the helicopter safely and efficiently in fire control work.

Neuns, Alva G.
Four-purpose enclosure card for training films. Fire Control Notes. 19 (3): 103-105, illus.

Specially designed card fits into film can with the training movie and serves to brief the trainer on the film's contents, mail out as an advance notice, provide a file copy for planning training sessions, and provide a brief guide on how to use a motion picture as a training aid.

Newport, C. A.
Can the quality index concept be used in ponderosa pine and sugar pine? Calif. Forest and Range Expt. Sta. Res. Note 141.

Describes a test of the stability of lumber price ratios for sugar pine and ponderosa pine over a period of 10 years. The ratios did not satisfy the test. Conclusion is that the quality index concept cannot be used in appraisals of these species because such an index assumes satisfactory stability in lumber price ratios.

Nord, E. C., and Knowles, Bert.
Rice hulls improve drilling bitterbrush seed. Calif. Forest and Range Expt. Sta. Res. Note 134. 5 pp.

Operating hints and seeding chart for sowing with rice hulls for uniform distribution with standard fluted-feed grain drill.

Offord, H. R., Quick, C. R., and Moss, V. D.
Blister rust control aided by the use of chemicals for killing ribes. Jour. Forestry. 56: 12-18.

Summarizes results of 15 years' work on the improvement of chemical methods for the control of currants and gooseberries in white pine forests of the United States. Factors affecting the use of 2, 4-D and 2, 4, 5-T under forest conditions are given special emphasis.

Pirsko, Arthur R.
Red, white, or blue—wear an extra shirt on the fireline. Fire Control Notes, 19 (3): 102.

More than 99 percent of the heat from burning forest fuels is in the invisible infrared region of the spectrum; therefore the color of fire-fighters clothing is less important than protection by two layers of clothes.

Poli, Adon, and Roberts, E. V.
Economics of the utilization of commercial timberland on livestock ranches in northwestern California. Calif. Forest and Range Expt. Sta. Misc. Paper 25. 51 pp., illus.

Should ranchers in northwestern California clearcut their timberlands and convert to grass, or should they manage these lands for timber production? In a study made to answer this question it was found that on suitable terrain and exposures and with proper management certain timber soils can be profitably converted to grassland, but that good quality timberland will yield more in the long run if left in timber than if converted to grassland.

Quick, C. R.
Herbicide tests on ribes continue in California. Western Weed Control Conf., Res. Comm. Progress Report 1958: 43-44. (Processed.)

Summarizes tests of herbicides on Ribes roezli Regel in California for the years 1956 and 1957.

Reppert, Jack N., and Green, Lisle R.
Annotated bibliography of publications from the San Joaquin Experimental Range. Calif. Forest and Range Expt. Sta. Tech. Paper 27. 32 pp.

Brief content descriptions of 135 publications dealing with range management, livestock production, zoological, and other aspects of the cooperative research program since establishment in 1934.

Righter, F. I.
Summary of forest tree improvement work in California. Northeastern Forest Tree Improvement Conf. Proc. Aug. 22-23, 1957.

Reports activities by various individuals and organizations having to do with forest tree improvement studies in California. Results of several studies at the Institute of Forest Genetics are mentioned: progeny test of a "plus" ponderosa pine; varietal crossing in Pinus contorta.

Righter, F. I., and Callaham, R. Z.
A California planting of progenies of "elite" and "non-elite" Pinus radiata from Australia. Calif. For. & Range Expt. Sta. Res. Note 135. 2 pp.

A 5-year study gave no evidence that two outstanding "elite" phenotypes growing in Australia produce wind-pollinated progenies that are inherently superior in growth rate to three wind-pollinated progenies from "non-elite" phenotypes in Australia.

Roy, D. F.
Forest management research in the Redwood-Douglas-fir region of California, a summary of foresters' views on research needs. Calif. Forest and Range Expt. Sta. Misc. Paper 24. 17 pp., illus.

Of several specific research needs, the most important are a site classification and yield tables, information on the results of various methods of cutting, a tree vigor classification for redwood, more knowledge regarding regeneration, and ways to improve and fully utilize material harvested from young-growth redwood stands.

Schubert, G. H.
California cone crop—1958. Calif. Forest and Range Expt. Sta. Res. Note 142. 5 pp.

Cone production in California was rated as medium or less for most commercial conifers. A few species had heavy crops in some seed zones, but even in these zones the crop size varied considerably.

Smith, R. H.
Additional host records for two bostrichid powder-post beetles. Jour. Econ. Ent. 51 (4): 556. August 1958.

The indigenous species, Scobicia declivis (Lec.), was found attacking imported logs of Philippine mahogany at a sawmill in Eldorado Co., Calif. An earlier record is cited of a non-indigenous species, Heterobostrychus aequalis (Waterh.) found in hickory returned to this country from the Philippines.

Smith, R. H.
Control of the turpentine beetle in naval stores stands by spraying attacked trees with benzene hexachloride. Jour. Forestry 56 (3): 190-194, illus.

One percent BHC gamma isomer solution in diesel oil or No. 2 fuel oil, sprayed on recently attacked trees, proved satisfactory for controlling the black turpentine beetle. This method reduces beetle activity without the necessity of cutting, reduces the incidence of attack, and reduces mortality of attacked trees.

Stanley, Robert G.
Gross respiratory and water uptake patterns in germinating sugar pine seed. Physiologia Plantarum. 11: 503-15.

The changes in dry weight, water, and oxygen uptake, and respiratory quotients during the first 72 hours of germination were followed for seeds of Pinus lambertiana. The possible significance of the lag period in germination is discussed.

Stanley, Robert G.
Terpene formation in pine. Symposium II., Biochemistry of Wood. Fourth Internatl. Cong. Biochem., Vienna, Austria. September 1958.

The theoretical pathways by which plants may form terpenes are reviewed and recent knowledge by which sterols are metabolized is used to provide a working hypothesis to explain the biogenesis of pine terpenes.

Stanley, Robert G.
Terpene formation in pine from mevalonic acid. Nature 182 (4637): 738-9.

Describes investigation which demonstrated that Pinus attenuata seedlings incorporated acetate-2-^{14}C and mevalonic acid-2-^{14} into α-pinene.

Stanley, Robert.G.
The physiology of forest trees. Chap. 31. Methods and concepts applied to a study of flowering in pine. The Ronald Press, New York. pp. 589-599.

Analysis by spectrophotometer and X-ray spectograph showed no differences in nucleic acid and micronutrients between reproductive and vegetative buds of pine. Discusses the potential role of an adaptive enzyme mechanism in facilitating growth of the pollen tube, fertilization, and embryo development.

Stanley, R. G., and Mirov, N. T.
Terpene analysis by gas chromatography. 133rd meeting, Amer. Chem. Soc. San Francisco, p. 6A. (Abstract.)

A report of the problems and benefits of analyzing complex pine turpentine mixtures by a rapid vapor-phase chromatography method. Pine terpenes obtained by classical distillation procedures provide standards for comparison.

Stanley, R. G., and Young, L. C. T.
Carbon dioxide fixation and glucose metabolism in germinating pine pollen. Plant Biochem. Sect. Fourth Internatl. Cong. Biochem., Vienna, Austria. p. 138. (Abstract.)

Evidence for the different enzyme pathways by which Pinus ponderosa pollen may metabolize glucose, and the role of metals and co-factors on the activity of these systems is discussed. Carbon dioxide fixation and its possible physiological role in pollen tube growth are reviewed.

Stanley, Robert G., Young, L. C. T., and Graham, J. S. D.
Carbon dioxide fixation in germinating pine pollen. Nature (London) 182: 738-9.

The capacity of germinating Pinus ponderosa pollen to incorporate radio-active CO_2 into organic acids and amino acids was investigated. The pathway of CO_2 fixation usually found in photosynthesizing tissue was also found to function in pine pollen.

Struble, G. R.
Lodgepole needle miner. U. S. Dept. Agr. Forest Pest Leaflet 22, 7 pp., illus., June 1958.

Contains information on the range, hosts, life stages, and habits. Evidence of infestation and biological and chemical control measures are discussed.

Struble, G. R., and Bedard, W. D.
Arthropod enemies of the lodgepole needle miner, Recurvaria milleri Busck (Lepidoptera:Gelechiidae). Pan-Pacific Ent. 34 (4): 181-186.

Contains an annotated list of parasitic and predaceous Arthropod enemies taken from lodgepole needle miner rearings and field collections. A short resume of what is known about the value of several species as control agents is included.

Wagener, W. W., and Bega, R. V.
The heart rots of incense-cedar. U. S. Dept. Agr. Forest Pest Leaflet 30. 7 pp., illus., October 1958.

Describes the principal heart rot of the species and other rots occasionally found in it.

Wagnon, K. A., Bentley, J. R., and Green, L. R.
Steer gains on annual-plant range pastures fertilized with sulfur. Jour. Range Mangt. 11: 177-182.

Carrying capacity and steer gains were materially increased during green- and dry-forage seasons; during late fall-early winter, inadequate-forage season, no benefits resulted.

Waklee, Floyd W., Shields, Herb, and Wilson, Carl C.
The helicopter joins the hose-lay team. Fire Control Notes. 19 (2): 88-90, illus.

Describes how helicopters can supplement ground equipment in laying fire hose over different types of vegetation.

Wickman, B. E.
Mortality of white fir following defoliation by the Douglas-fir tussock moth in California, 1957. Calif. Forest and Range Expt. Sta. Forest Res. Note 137. 4 pp., illus.

Defoliation of white fir by the Douglas-fir tussock moth between 1954 and 1956 resulted in considerable tree mortality. Only those trees defoliated from 50 to 100 percent had died by 1957.

Wilson, Carl C.
Control of aircraft on forest fires. Fire Control Notes. 19 (2): 35-39.

Describes the functions necessary for safely controlling a complex operation of aircraft on forest fires and suggests one way of fitting these functions into the over-all fire control organization.

GPO 977655